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## Investigating the use of audio materials to support mathematical learning: from curriculum access to reflective reciprocal learning

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# Investigating the use of audio materials to support mathematical learning: from curriculum access to reflective reciprocal learning

Thesis submitted in fulfilment of the regulations for the award  
of Doctor of Philosophy

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# Abstract

I was motivated to undertake this research by concerns that arose from my professional and personal experiences in education. I was concerned that students with visual impairment were not being offered equality of access to the mathematics curriculum. Some schools cited high visual content as a reason for withdrawing students from mainstream classrooms.

The study set out to pursue the thesis that students' experiences in mathematics education could be enhanced and extended through using audio recordings as complementary means of learning. It was carried out, in a variety of settings, with students of upper primary and secondary age.

The value of applying a multi-method approach became evident over three years of fieldwork. I supplemented Soft Systems Methodology (Checkland and Scholes, 1990) with principles from other methodologies in response to feedback on use and production of audio materials. Students made invaluable, constructive contributions in their roles as co-researchers. An action-research approach evolved as most appropriate for the study.

A complex interplay of factors was found to affect the extent to which audio recordings could be facilitative of inclusion. As well as analysing these factors and considering their wider implications, this account describes how my original formulation of the research in terms of issues of access became reconceived in terms of reflective, reciprocal learning.

The study opened up sources of information that, seemingly, were being unexplored, under used, under valued and under researched, namely the resources that students themselves possessed. The study drew on case study material relating to the learning experienced by individual students to explore an emerging concept of reciprocal learning, both as a pedagogic

relationship facilitative of inclusion and as a method for practitioner research. It is recommended that further exploration of the potential value of a reciprocal learning approach should form the basis of future research.

# Chapter 1: Overview, Research Beginnings and Developments

## Introduction

In 1998, schools were still citing the high visual content of mathematics as reasons why students<sup>1</sup> with sight disability should be educated in special schools or be withdrawn from mainstream lessons. I was motivated to undertake this research by concerns that arose from my work in these fields of education. I was concerned that claims being made that all students were being offered equality of access to information in print were not being realised in practice.

The study originated from the thesis that students' experiences in mathematics education can be enhanced and extended through use of audio recordings as a complementary means of learning. I set out to investigate the part that audio recordings might play in facilitating inclusiveness in mathematics for students in mainstream classes.

An initial intention was to share my knowledge, experience and skills with others with the hope that use of a recorded audio medium by students would become an accepted process in mainstream classrooms. I wanted to find ways of improving students' chances to take an active role and participate more fully in mathematics education. My aspiration was that the audio process would offer a feasible alternative to excluding students from working alongside their peers in their local schools. Outcomes would depend on participants communicating their criticisms and suggestions for changes in use and production of the audio materials.

<sup>1</sup> 'student' is used when referring to young people in this study

I was embarking on a journey of discovery and learning. On the one hand, I was full of confidence that my personal and professional background would make introduction of the study into schools straightforward. On the other hand, I was apprehensive that I would be stepping into the unknown when I started the main study as an outside researcher. I would have no official professional responsibilities within a school or educational requirements specified by sponsors. At this stage I managed these mixed feelings by devoting time to thorough theoretical preparation in an endeavour to feel in control and prevent problems from arising at the outset.

I was reassured by the enthusiastic response from senior managers in the two schools in which I undertook a pilot study. It seemed that when I introduced this innovation that it was going to be well received and supported. I looked forward to working in harmony with both adults and students. In reality a complex interplay of factors was found to affect the extent to which audio recordings could be facilitative of inclusion.

Initially I cited young people with visual impairment as the target population but as a result of taking action in response to feedback from participants, this eventually changed to inviting any student working towards the Key Stage 3 national tests (SATs)<sup>2</sup> to try using the audio process. Students without sight disabilities were included. I did not anticipate the necessity that arose to address, in-depth, pedagogical issues associated with mathematics and audio technology. I had little conception of the challenges that lay ahead or the range of emotions that I would experience during three years of fieldwork.

While my expectations and aspirations changed as the study progressed I introduced the study as I had intended from the

<sup>2</sup> Standard Attainment Tests (SATs) taken by students at the end of Year 9.



outset. I give information and explanations about participants and events in the order that they played a significant role in the research. There were unexpected setbacks that required making difficult decisions concerning how or whether to continue undertaking the investigation. In contrast other incidents provided insight into the resourcefulness and abilities of individuals who took part, in some cases for over a year. The methodological changes that I made eventually led to adopting a mainly action-research approach.

I have embedded literature rather than presenting a separate literature review chapter. The origins of this research stemmed from my past and more recent experiences in mathematics education. Quotations and references to literature are interwoven in the narrative to communicate the many ways in which the work of others actively informed my reflection upon, and analysis of data, collected during fieldwork. It was interdependence between theory and practice, not competition between these aspects of the research, that guided my thinking. Reading and listening to theories of philosophers, researchers, scholars and other practitioners gave me different perspectives on the varying aspects of the study and helped to clarify my own thoughts. The knowledge and experience of others, especially students, inspired confidence to continue to pursue my vision of how matters might be improved for those struggling to learn mathematics, sometimes against overwhelming odds. I applied the approach summarised by Winter (2002b):

theoretical resources are not predefined in advance,  
but are drawn in by the process of the inquiry ...  
action research is necessarily just as much to do  
with the process of the inquiry as with the  
substantive topic ... action research itself involves  
*deciding how best to intervene here and now*, in this  
situation, with these various individuals in the

light of these social and professional values, amidst the complex pressures of the organisational and political context.

(Winter 2002b, pp. 37-39)

### *Why narrative style?*

I decided to write in narrative mode rather than a paradigmatic mode, as defined by Bruner (1986) because of the nature of the study. Bruner (1986, p.11) argues that, "there are two modes of cognitive functioning, two modes of thought, each providing distinctive ways of ordering experience, of constructing reality". These forms of cognition are "irreducible to each other" because each has "operating principles of its own and its own criteria of well formedness". From this perspective narrative knowledge is a legitimate form of knowing.

Events and dialogue in one phase influenced decision-making and action in subsequent phases and I was aiming to portray a description of reality that reflected the views of others as well as my own. Bruner (1990) points out other properties of narrative that I found were particularly pertinent to writing an account of this research. He suggests that "its principal property is its inherent sequentiality: a narrative is composed of a unique sequence of events, mental states, happenings involving human beings as characters or actors" (Bruner 1990, p.43). Outcomes of the research depended on working collaboratively with many individuals and responding, non-judgementally, to their voices. Bruner goes on to argue that, "one of the most ubiquitous and powerful discourse forms in human communication is *narrative*" (p.77). Winter (2002) links writing in narrative form with action-research principles:

the central purpose of an action research report is to carry through some form of change in practice, so that an action research report necessarily describes

a sequence of events developing through time; its form is, therefore, essentially that of a narrative ... it does not seek to create generalisations, but rather, an account of a specific situation that gets sufficiently close to its *underlying structure* to enable others to see potential similarities with other situations.

(Winter 2002a, p.143)

The story of this study contains many of the constituents that Bruner (1986, p.14) mentions in his likening of story writing to constructing "two landscapes simultaneously". I started with a definite "intention or goal" but situations that arose affected the course of the study. I soon realised the need to find out "what those involved in the action know, think, or feel, or do not know, think or feel". It was the seeking to explain, "precisely how plight, character and consciousness are integrated" (ibid, p.20) when things went awry that resulted in a complex story with unexpected turns. I questioned myself as well as participants when applying this newly found consciousness.

## **Past Personal and Professional Background**

I start this account with an autobiographical section in which I make explicit details of my background that I consider were relevant to this research. I kept in mind the comment that "the presuppositions we lace into telling of our lives are deep and virtually limitless ... why things are included remains mostly implicit" (Bruner 1986, p.122).

I am aware that my beliefs, values, interests and aspirations have been affected by personal experience. Together these have been highly influential over this current study:

it is the active interaction of subject knowledge, school knowledge and pedagogical understanding and experience that brings teacher professional knowledge into being. Lying at the heart of this dynamic process are ... a complex amalgam of past knowledge, experiences of learning, a personal view of what constitutes, 'good' teaching and belief in the purposes of the subject.

(Banks, Leach & Moon 1999, p.95)

I discovered that it was an essential requirement for all involved in the study to acknowledge experiences from the past and recognise how these may be affecting present thoughts, feelings and actions. This requirement was not confined to teachers.

I was aware of the issues of subjectivity from my experiences as a practitioner in education. Jaworski (1994) writes that "rigour resides in the ability of the researcher to convince the reader of the fit between data and analysis, and this requires the researcher to justify subjective decisions made" (p.75). This reinforced my thoughts about ensuring that preconceived ideas and assumptions were acknowledged when collecting and analysing data collected in educational situations, that were by nature social and therefore open to subjective interpretation.

My study took place during the introduction of the National Numeracy Strategy (NNS) and explored specified difficulties in mathematics being encountered by students. Jaworski's (1994) research was completed in 1991 and concerned "close scrutiny of a small number of mathematics teachers" exploring "an *investigative approach to mathematics teaching*". I share her views of how a researcher's role can affect interactions and her assertion that claims made on subjective grounds must be

substantiated. Other features common to both studies were the significant part played by participants' interpretation of mathematical language and the essential requirement as a researcher to keep in mind "whose story I am actually telling" (Jaworski 1994, p.186). Through the process of reflection I took conscious steps to be reflective and transparent about the influences of my personal background on judgements made and decision-making before, during and after action.

### *My experiences as a pupil in school*

It was the shortcomings in my own mathematics education combined with experiences in education as a teacher, supporter and then an advisor that heightened my awareness of how the pedagogy in this field can be radically affected by the ideologies of organisations and individuals who interact within these.

I had never associated interest or enjoyment with mathematics when studying this subject but I derived satisfaction from passing examinations. No one suggested that I should try different methods or play with numbers. I disliked being forced to memorise theorems for geometry in order to reproduce these verbatim in tests. I did not discover mathematics in the way described by Mason (below) until I was a qualified teacher. I find it ironic that the answer to the question, 'What is mathematics?' is most aptly summed up for me, now, in his words about Geometry:

I find it useful to think of mathematics as a world which one enters—not a world in which something is either true or false, but a world in which one experiences contexts in which there is truth, falsehood and unknowability. Geometrical activity is one excellent way of gaining access to that world, through the power of mental images, through seeing



through diagrams to world of generality which can be read into them. It is one way to encounter the discipline of mathematics, where convincing people why something is a fact is as important as finding out what the fact is.

(Mason 1991, p.84)

### *Teaching in a special school*

My opportunity to find a different world of mathematics came when I changed direction in my teaching career and applied for a post in a school for students who were registered as blind. I had no qualifications to teach the Visually Handicapped<sup>3</sup>. In later years students were referred to as being visually impaired (VI). I obtained the statutory specialist qualification within the time stipulated but I knew little about current mathematical schemes. I concentrated on trying to find appropriate ways of presenting visually oriented topics. Students could not access the 'world of generality' through seeing in the visual sense but could experience a similar meaningful 'world' of 'truth, falsehood and unknowability', as their fully sighted peers through a multi-sensory approach.

An event that proved to be significant to how I proceeded with my work in the special school was a visit, six months after I started my job, by a mathematics inspector from the Inner London Education Authority (ILEA) in connection with a previous HMI Inspection. She took an interest in my search for suitable materials. She suggested the Schools Mathematics, Individual, Learning Experiment (SMILE)<sup>4</sup> for mixed ability classes, which

<sup>3</sup> The term 'Visually Handicapped' is no longer used. The most usual phrase is children with visual impairment (VI) but the RNIB Press Office prefers the term 'Blind', 'Partial Sight' or 'serious sight problem'.

<sup>4</sup> SMILE: Schools Mathematics Individual Learning Environment. The letter 'E' originally stood for 'Experiment' (SMILE Centre 2000)

was being supported in London schools. She had no knowledge or experience of working with students with VI. I raised the issue of how to tackle tasks dependent on diagrams, when these had been omitted from the textbooks supplied in Braille. Students were being required to follow a restricted mathematics curriculum. The children's sight loss varied from total loss, congenital or sudden, to chronic conditions affecting vision. I could empathise with their difficulties in understanding a topic because they did not have the necessary prior knowledge. Missing knowledge in my case had been caused by frequently changing schools during the Second World War rather than absence caused by health problems or unavailability of materials but the effect was similar.

A variety of presentation and media was essential in this environment. I thought that SMILE offered a scheme that could be used as a structure for planning individual learning programmes but the idea was strongly opposed by an established body of people who regarded themselves as 'experts' in the field of visual impairment. I was questioned about the wisdom of introducing a scheme with such a high visual content and taking advice from an inspector with no specialist qualifications in VI. I was faced with the task of providing sufficient evidence to show doubters that students could enjoy and benefit academically from exploring the visual aspect of mathematics that were being offered to their fully sighted peers in mainstream. After many monitoring visits, my proposal to make this scheme accessible to Braille users was approved by the ILEA, although there was still strong criticism from some VI specialists in other special schools.

The SMILE cards were visually attractive with stimulating colours and pictures accompanying text. Producing work cards in Braille and tactile diagrams with a full teaching commitment proved too demanding. I started to record text onto audiotapes.

I could reproduce more mathematical information for students having difficulty learning Braille and unable to examine diagrams easily. Students could work without constant help, by listening to questions and descriptions of diagrams. Examination candidates did not have to rely on inexperienced amanuenses. The majority of students became enthusiastic and interested as they regained a degree of independence and realised that they could progress in this subject without good vision or Braille skills. Judged mainly but not entirely on results of further inspections and examination grades, the SMILE scheme was deemed appropriate in this school and was adopted by other special schools.

The Media Resources Officer (MRO), who worked full-time in the special school, worked creatively with children out of school hours, inserting music and drama on tapes to substitute the visual displays on the work cards. A transcriber took over most of the Braille production and technological items requested were purchased. Another teacher was appointed to work with me in the secondary mathematics department. I had time and assistance to produce SMILE materials, and introduce students to project work and 'Everyday Mathematics' that, at that time, were the other flagships of the Government's educational policy. A creative approach stimulated interest in mathematics for many students.

I was in the special school long enough to provide substantial evidence in practice to show that new ideas, like use of audiotapes for mathematics, can be beneficial to at least some students if they are given a chance and the means to try them. I was fortunate to be supported by a person influential in education. However I did not have adequate time to pass on necessary information and skills concerning the innovatory ideas that I had introduced including use of audiotapes for mathematics. Reports I received from colleagues, after I had

left the school, indicated that continuity for students had been disrupted due to people who took over my work not being sufficiently conversant with it.

### *Balancing theory and practice*

Whilst still working in the special school I enrolled to study for a degree with the Open University (OU). My main method of studying was through distance learning. A project that I completed for a preliminary course 'Mathematics Across the Curriculum' heightened my awareness of the use of mathematics in other subjects and in activities outside school hours. I became increasingly conscious of connectedness between topics that I had regarded, in my own education, as a disjointed series of exercises selected at random.

### *Returning to mainstream teaching*

My firm commitment to the principle that all children should have opportunity to be educated in their neighbourhood schools led to returning to teaching in comprehensive schools. Categorisation of children under disability labels was against the policy of equal opportunity being promoted at this time. Speakers and writers were careful about the terminology that they employed to the extent that it was difficult to know if a visually impaired child had good residual vision or none. The contrast between the protected, unworldly, environment of the special school and a comprehensive school of over 1500 students left me in no doubt about the stressful task for teachers required to maintain discipline and meet the many other demands on them.

At this time recommendations in the 1981 Act, outlined an expectation that all pupils would be educated in mainstream schools, were subject to the requirement of necessary resources being available. The lack of effectiveness of the Act was due to insufficient clarity in the guidelines to ensure that it

would be enforceable by law. An ex-colleague contacted me to ask if I would consider supporting a blind pupil, Alex, who wanted to attend his local comprehensive school. His parents were looking for a support person. The Head of Mathematics in the school strongly supported integration. She was a respected Union representative and managed to persuade the Head to accept Alex on roll. I eventually agreed to work as his individual support teacher (IST), not knowing that I was embarking on a seven-year engagement.

### *The role of an Individual Support Teacher in Mainstream*

This was my second encounter with resistance to change by so-called experts, in this context in the field of Special Education. The first year was a testing time. I required all the skills that I had acquired since I began teaching. The SMILE scheme was established in the school. The inspector for the school and many professionals in the field of visual impairment forecast failure and academic deprivation for Alex. This was an example of the need to show in practice how an innovation can work out to be in the best interests of not only one student selected but also offer valuable new learning experiences for other students and adults.

A teacher who taught Alex pure and applied mathematics at A Level became expert at giving a running commentary as he drew complicated diagrams on the board. I spent many enlightening hours in his classroom followed by discussions to review and plan lessons in advance to assist him in acquiring the art of verbalisation.

Alex was a competent Braille reader and writer and preferred this medium for learning. He used audio only when tactile materials were unavailable. Giving Alex the opportunity to choose which medium was appropriate for him resulted in a productive working relationship founded on mutual trust and respect. He was interested in technology and tested out new



equipment and programs supplied by manufacturers that ranged from the VersaBraille and Navigator machines to piloting translation programs for mathematics. Two of my reports relating to work with Alex were published (1989, 1991).

Alex expressed his views on integration at the end of his secondary education. He felt that all students should *"not just be in the school but part of it as a person, socially as well as academically succeeding and not to feel special."* When he entered University I accepted a post as lecturer for the module 'Children with Disabilities of Sight' that was part of the University of London Institute of Education course for teachers requiring additional qualifications for working with children with VI. I realised from this experience how little attention is focused, in teacher training, on the art of listening. Audio materials were barely mentioned in the course handouts about differentiating curricular materials. In this work and later when I took over responsibility for a VI Service in a London Borough, I observed adults endeavouring to put inclusion into practice in 35 London schools. I could not fail to notice the numbers of pupils without visual difficulties asking their teacher or friends for help to read examples and questions from verbose mathematics textbooks. Katie, a student whom I supported in a large comprehensive school, in the early 1980s, stated her opinion about inclusion, emphatically, before she lost her battle against cancer *"it is essential to be involved in discussions so that decisions are not made for me, but take into account my ideas and suggestions."*

### *Running an Advisory Service*

In the late 1990s I took over responsibility for running a Visual Impairment Service in a London Borough. In all the classrooms that I visited in an advisory capacity I found students encountering accessing difficulties for a variety of reasons. From this experience I realised the extent to which

accessing problems in mathematics were causing frustration to many individuals, who were not entitled to additional advice and provision, because they had not been awarded an official statement of special educational needs. I was granted funding for a small-scale audio unit as an addition to the Production Room that I had established for Braille and large print materials. Researching types and costs of appropriate equipment and negotiating with manufacturers and suppliers extended the knowledge that I had gained through an earlier project to set up a loan pool of equipment for the ILEA. I was able to get to know the manufacturers' and suppliers' business world when I was selecting and purchasing technological items.

Mathematics is a core subject in the National Curriculum and is regarded as a status subject in schools. It can open doors to future careers and lucrative living. These sought-after outcomes may explain why many individuals think of themselves as inadequate and failures if they cannot reach levels of attainment set for them. The turning point in my teaching career, concerning my understanding of issues of inclusion, had been the decision to move from working in the exclusive environment of a special school to taking a practical role in the controversy concerning integrating students in mainstream schools. The terms inclusion or inclusions and more recently inclusive learning or inclusiveness superseded the term 'integration' but debates about the meaning of these phrases continued. In the following section I make my views explicit in relation to this research study.

## **Inclusiveness**

My interpretation of integration, inclusion and more recently inclusiveness gradually evolved as I observed and participated in the process in environments claiming to offer inclusive learning and an inclusive curriculum. I took part in debates with children, parents and professionals where opposing views

were strongly voiced, for example in decision-making for Alex's future in education and the course of action to take when Katie's health deteriorated. As a parent myself, I was committed to the ideal of inclusiveness in learning for all students but I would have found it a frightening prospect to be expected to transfer my children, if they had been disabled, into mainstream education without knowing likely implications.

I was in agreement with an argument against use of the single term inclusion made by Dyson (1999 pp48-49) "inclusion is not a monolithic concept; there are multiple versions of inclusion, so that it makes sense to talk about 'inclusions' in the plural". In my experience outcomes for individuals had been different and unpredictable. Nind, Simmons, Sheehy and Rix (2003, p.2) endorse this argument that, "our notions of inclusion and inclusive education are not fixed. This is a fluid concept".

### *The current study*

The study that I was proposing to undertake stemmed from my experiences of mathematics education described in this chapter. Pedagogical issues became the major focus of the study. The overarching question at the start of the study was: what part might audio recordings play in facilitating inclusiveness in mathematics in mainstream classes? I adopted an approach similar to the one described by Ollerton and Watson (2001, p.3) "looking at what it means to teach and learn mathematics and attempting to give students access to the curriculum as it is, within the assessment structure as it is."

I did not assume that access alone would provide a means of ensuring inclusiveness. One intention was to enable students encountering problems, due to difficulty in seeing or reading print, to exercise a degree of control over their own learning equivalent to their peers. I wanted to enable participants to

be actively involved in the research, therefore, I was continually searching to open opportunities for students and adults to play a full and equal part in decision-making and implementing ideas in practice. I was thinking along the same lines as Florian (1998, pp.16-17) that "opportunity to participate implies active involvement and choice as opposed to the passive receipt of a pattern or condition that had been made available", but in this study providing opportunity did not automatically result in active involvement.

I held the opinion that young people should be offered an adequate and appropriately resourced option to be educated in mainstream. There seemed no justification in citing accessing problems to visual materials as a reason why students should be withdrawn from mathematics lessons or, as happened in the past in some instances, from attending a mainstream school.

My interpretation of inclusive education in the context of this study incorporates the same issues that are central in education for us all, "it is unquestionably the function of education to enable people, individual human beings, to operate at their fullest potential, to equip them with tools and the sense of opportunity to use their wits, skills, and passions to the fullest" (Bruner 1996, p.67).

## **Present aims originating from past experiences**

Based on omissions in my own school mathematics education I would be looking for ways to engender interest and enjoyment for students studying mathematics. In addition I wanted to enable them to attain their full academic potential and offer means for them to work independently when required.

When I started teaching in a special school I relied on assistance from twin boys who were both blind. I was helping them work towards taking external mathematics examinations at the end of the year and they were passing on their Braille

skills to me. This was my first experience of collaborative learning with and from students. It was one that I valued and became an aim to replicate during the study. I also realised how low expectations within a school could undermine confidence of students in their own abilities. I would try to set realistic academic and social targets for students taking part in the study.

The experience of introducing the SMILE mathematics scheme into the special school enabled me to understand the dilemma of present Heads of Mathematics, whose departments are often judged purely on the grounds of examination grades or National Curriculum Levels attained. I intended to emphasise the importance of the many other aspects of the subject not only focus on academic achievement. I was determined to seize every opportunity to encourage students to apply their creative ability and skills to learning mathematics and production and use of audio materials.

I was anxious to avoid disruption for students as occurred when I left the special school without time to prepare others to take over my work. An instigator of an innovation needs to plan and pass on information well in advance of expecting others to continue along the same lines. I resolved to allocate enough time to make arrangements for changes in personnel, whilst I was still working in a situation.

Studying at degree level with the Open University opened up for me new ways of thinking mathematically. I wanted to share this revelation with adults as well as students in schools who like me had been denied this in earlier years. I did not know at this stage that distance-learning would be an integral aspect of the study in one of the phases.

It could have been the traumatic experience of taking a post in a school of nearly 2000 pupils that made me realise the incredible pressures on teachers today and enabled me to

support, advise and undertake research in schools, without being unreasonably critical of teachers trying to cope with large classes and disruptive pupils. I would consider incidents from other people's perspective rather than make immediate judgements and arrive at conclusions without consulting all participants.

Learning experiences from the early years in the special school and support work in mainstream persuaded me that one way of convincing others of the potential value of an innovation was to be prepared to operate with less than ideal resources at first. Knowing the complications that could arise if resources were not in place at the start, my prime aim was to investigate and acquire basic audio hardware and software before introducing the audio process into schools. I could not predict the appropriateness of these initial choices until the study was in progress.

I kept notes that I made over two years when Alex was studying for A levels. I planned to refer to these when I was writing scripts and training script writers and narrators to help with audio production of mathematical information, including describing diagrams, from textbooks.

I was against imposing a way of learning without offering alternatives that might increase negative feelings and lower self-confidence. I learned from Alex that offering a choice of media was important. I wanted to offer this option to other students. I intended to apply the knowledge and skills that I acquired when working with Alex to evaluate new technology as part of a project in progress at the Research Centre at Birmingham. I would be able to incorporate ways of assessing equipment and writing reports when I was researching good quality, low cost audio hardware suitable for mainstream classrooms and audio reproduction.

Collaborative work in this case was on the technical side. I wrote a practical guide entitled 'A visually Impaired Pupil in Secondary Mainstream, Implications for you?', that suggested ideas for others setting out on the task of integrating a student into mainstream classrooms. Alex's comment about the social aspect of integration and Katie's remark about allowing her to take an active part in decision-making would always serve as reminders of the importance of both these aspects of the study.

In my role of support teacher for Alex I worked within classes of thirty students. I observed other students without obvious disabilities struggling with 'accessing' (Booth, 1992) mathematics presented orally and in print. The move from teaching in a special school to supporting a blind student in a comprehensive school had plunged me into the controversial world of integration. I recalled memories of those 'other students' later in this research when an unexpected opportunity opened to include, in the research, students without impaired vision.

In my other roles as a teacher of mathematics in a comprehensive School in London, a lecturer for a University Course and finally as a Co-ordinator of an LEA VI Service I had been under stress resulting from the ever-increasing demands for paperwork and the constant stream of new schemes and examinations in mathematics being forced onto schools. Based on firsthand involvement in administrative posts, I was confident that I would be able to empathise with adults working in schools in the late 1990s. I would keep in mind, throughout the study, Bisi's writing from the perspective of a blind teacher.

I was committed to questioning the rationale and justification for any critical feelings that may be foremost in my thoughts about happenings in classrooms and the role that I had taken in an event or dialogue.

## Methodology

I did not map out a set path for the study or plan to manipulate situations to fit a pre-defined model.

Methodological decisions that I made at the outset were intended to be flexible and open to change as I had no conception of what would happen in reality. Changes in methodology and in some instances the path of the whole study resulted from reflection on findings from analysis of data collected during incidents and dialogue that had been identified as significant at the time.

In 1989, I undertook a research project in which I applied the principles of Soft Systems Methodology (SSM) (Checkland, 1989) and therefore I turned to this approach when initial ways of collecting data were found to be unsatisfactory. As the study progressed I supplemented this approach with principles from other methodologies. I finally adopted a predominantly action-research approach selected for its appropriateness for working towards the purpose of the research and the contexts in which the study was being undertaken.

As well as analysing factors that affected the degree of inclusion possible and considering their wider implications, I describe how my original formulation of the research in terms of issues of access became reconceived in terms of roles and differing styles of learning. Decisions to make organisational and methodological changes were guided by reactions of participants to events and dialogue that occurred in practice. My understanding of students as learners was deepened and extended by having the flexibility to make changes in how I gathered data and altered methods used for analysis to ensure that this fitted the type of data obtained (See Chapter 2).

I had learnt, from past experience, that some students were able to participate to a greater extent in mathematical



learning if they could obtain information presented in print more easily. In the following section I outline the structure of the thesis that addresses issues of how I planned and put into action ways of working towards the aim of opening opportunities for students to experience inclusiveness as defined in this chapter and enabling them to play an active part in taking opportunities offered and sharing their knowledge and skills with others.

## Thesis structure

The thesis has a narrative structure. I introduce individuals in chronological order giving information about them relevant to significant incidents, as these occurred. Readers can refer to case studies in Appendix 1 to obtain details about main contributors and CHAMPE (a two-year funded project run during the study).

In this chapter I have given an autobiographical account intended to inform judgements about, not only what decisions I made and how I applied these in practice, but also my reasons and roles that I took in action. I discovered that getting to know relevant background details about participants in this study enabled me to gain greater insight into understanding reasons for their words and actions and the conclusions that they reached.

Throughout the account, in subsequent chapters, I describe and offer interpretations of critical incidents that I refer to as 'key' incidents<sup>5</sup> that occurred during the study. I was self-questioning concerning how my personal agenda might have influenced my explanations of events and dialogue. People questioned my motivation for undertaking this research and why

<sup>5</sup> 'Key' incidents: events or dialogue that opened or closed opportunity and were turning point in the investigation. (based on Tripp's 'critical incidents' (1993))

I was introducing this particular innovation into mainstream schools. I faced opposition that on occasions seemed destined to destroy all hope of development, but I found that talking about facts and examples from a practitioner's point of view aroused sufficient interest to engage most individuals in constructive discussions. To what extent I succeed in communicating my thoughts and ideas will depend on the "the meaning of the narrative inside some listener's or reader's head" (McGuire 1990, p.229).

Chapter 2, entitled 'Methodology Metamorphosis', traces how action-research evolved as an appropriate approach for this study. Soft Systems Methodology and principles and techniques from other research methodologies were employed to complement and supplement data collection and analysis. I provide illustrative examples to enable readers to follow the story of the study as it unfolded. I explain the purpose of the pilot studies and how students were selected to take part in these and encouraged to make decisions for themselves on whether to continue their involvement in the study. I describe how I negotiated entry into schools and modified and adapted my roles in response to what was happening in reality. My role changed from accommodating to conditions in classrooms to striving to open up greater opportunity for students to fully participate in learning mathematics and associate this core curricular subject with creativity, interest and enjoyment. In my endeavours to succeed in this quest, I followed Hart's (2000, p.13) advice to try "to move out of our own frames of reference and view the situation through the child's eyes".

In chapter 3, 'Audio Means for Accessing and Enhancing Mathematical Experience', I examine issues associated with mathematics and mathematics education. I discuss pedagogy in relation to acquiring and applying mathematical knowledge and skills through audio technology. I describe and explain how

language and listening skills were developed to facilitate use and production of audio software to assist making sense of mathematics, raise levels of interest and enable students to experience satisfaction through personal and academic progress recognised by others.

In Chapter 4, 'Inclusive or Exclusive Learning?', I give an account of experiences of students who were the main contributors to the study. I have protected anonymity by not using real names. I attempt to explain reasons for the barriers encountered by students as they struggled to follow their preferred ways of learning and why the outcome was all too often exclusion. I did not predict the strong reactions to the innovation of introducing audio materials into mathematics education in spite of many years spent in this area of education and my work with young people with visual impairment. I question why inclusiveness proved to be such an elusive aim to achieve. This required examining the use and misuse of power and missing resources. Endeavours to overcome barriers to inclusiveness led to the realisation that little could be achieved unless adults were willing to learn from students, and students were allowed and enabled to communicate and contribute to action with adults on equal terms.

In Chapter 5, 'Reflective Reciprocal Learning', Figure 5.1 shows the chronological order of events that includes an overview of phases of fieldwork interspersed with recesses when I was not in direct contact with participants. I describe how opportunities were opened for two-way learning relationships to be formed between student and adults and the outcomes for participants. I describe the emergence of a concept at the heart of the study, that I termed 'reciprocal learning'. It started with instinctive and intuitive responses to people and events within schools and progressed to conscious deliberate development of activities that were identified as major

influencing factors in this collaborative form of communication and action. I quote students and adults who were key contributors and give examples of how many of us benefited from interchanging roles and discovering how differences can enrich working relationships and expose previously unknown and unused abilities and interests of individuals.

In the final chapter, I use the experience of the research to review how applying the characteristics identified as being vital for reciprocal learning may contribute to facilitating inclusiveness for students in mathematics education in the future.

# Chapter 2: Methodology metamorphosis, Part 1

## Introduction

In this chapter I tell the story of a methodological journey undertaken for the purpose of offering opportunity for accessing information in print more easily and finding out how this could best be done. I decided to write the story in two parts because I spent the first six months running a pilot study. I analysed data to find out if introducing the innovation into mainstream schools might be feasible and acceptable. In Part 2, I describe and explain how I used findings to guide methodology at the beginning of the main research study. I implemented changes and utilised principles from other research approaches when appropriate.

The aim was to enhance and extend mathematical experiences for students. I was proposing to offer them opportunity to use audio recordings as an alternative or complementary medium to assist their learning in this core curricular subject. I knew from previous experience that students with visual impairment in segregated settings had been helped through listening as they struggled to read print information. I assumed that to demonstrate similar advantages for students in mainstream would be a matter of refining and evaluating production and use of a similar audio process. With hindsight, I appreciate the amount and variety of learning that took place for all participants including myself. Learning went way beyond the confines of classrooms, mathematics and audio technology.

I realise in retrospect that when I embarked on this project initially, I brought to my preliminary thinking and planning a formulation of aims and questions and a set of expectations about methodology that were broadly positivistic in

orientation. The pilot phase of the research led me to question not just the particular methods I had chosen to use but also the whole orientation of the research approach that I was adopting. As a result, I shifted both my orientation and my enquiry methods towards a more interpretative approach. As this approach itself evolved in the field, I came to perceive my overall approach as a form of action research. I examine and explain approaches used and changed during each phase of the research and the nature of the experiences and learning that led to these various shifts of understanding. Table 2.1 below shows the different methodological approaches applied:

TABLE 2.1 METHODOLOGICAL APPROACHES

**PART 1 Phase 1 and Recess 1**

<b>PREPARATION</b>	<b>INFLUENCES</b>	<b>TREND</b>	<b>METHODOLOGY</b>
PHASE 1 April – July 1998 aims and questions pilot study plans; data collection; role; schools 1 & 2 Caroline, Linda	practitioner experience literature personal ideology SSM Mode 1	predominantly positivist	Empiricist positivist
RECESS 1 August 1998 Pilot study report researching audio hardware & software;	analysis: critical incidents; observation & interview data; postmodern;	supplementary qualitative approaches	case study interpretivist/ hermeneutic reflection-on-action

**PART 2 PHASES AND RECESSES 2, 3, 4**

PHASE 2 Sept-Dec 1998 main study: school 3 & 4; inclusion and exclusion; applied for funds for a project Mohammed , Thomas	environmental & external factors; constraints on communication	becoming critical questioning; mainly qualitative	covert action- research case studies interpretivist
RECESS 2 December 1998 re-analysis of critical incidents; evolution of action-research;	computer analysis; SSM Modes 2 and 3 for analysis	aim for improvement through implementing necessary changes	overt action research plans

school 5 selected PHASE 3 January – March 1999 Inclusive mathematics in school 5; plans made for funded project; Derek et al RECESS 3 April –August 1999 Data analysis; return to theory; developing audio production and distance learning PHASE 4 Sept 1999 – May 2000 case study completed; new case study overcoming barriers	power/knowledge  key incidents; opening opportunity to more students reflection-in-action  writings and ideas of philosophers, scholars and practitioners  change in target population; SATs conditions;	communicating to make changes and work collaboratively  extended break; time for reflection and planning  emancipatory and participatory action reciprocal learning	action research in action  multi- method review  action research
Stephen et al RECESS 4 August 2000 overseas contacts revisited; up date on audio technology PHASE 5 Sept 2000 to end of study constraints on audio and inclusive mathematics;	reciprocal learning reports in USA; alternatives to tapes  changes in roles, norms values, environments people with power	collaborative decision-making and action through opening more lines of communication  multi-method: action research, SSM, interpretative and critical approach	

I was in touch with current thinking and policies in the field of visual impairment and how participating in mainstream classes could advantage or disadvantage students with sight disabilities. I was not well enough informed about the NNS due to be piloted in schools. The Framework for Key Stages 1 and 2 that contained yearly teaching programmes for mathematics was to be extended to Year 7 in 1999. My knowledge of audio technology was out of date. In the weeks before the Christmas holidays in 1998, I attended INSET sessions on mathematics and talked to inspectors and professionals in mathematics education. I researched audio equipment and production in the UK, consulted practitioners and academics about methods they suggested, and in some cases had tried, for introducing innovations into mainstream schools and read relevant publications. The drawback was that I could not, immediately,

apply in schools the knowledge that I was acquiring from reading and consultations.

## **Phase 1 Preparation & pilot study (November 1997 to July 1998)**

I consulted children, their parents and people in the schools likely to be involved, before making any definite decisions about which children to select for the pilot study. I chose two students with visual impairment from my case list. Caroline had no sight and Linda was partially sighted (See Appendix 1). Both students were experiencing difficulties accessing print text and diagrams. They attended schools 1 and 2, respectively. The purpose of the pilot was to find out the feasibility of introducing use of audiotapes into mainstream classrooms as a complementary means of accessing mathematical information to assist learning.

I was interested in how students and those working with them would react and respond to use of audio equipment and materials. In my capacity as the co-ordinator of the VI Service, I had observed subjects across the curriculum in schools 1 and 2 but never had time to remain in classrooms for entire lessons. I observed possible environmental constraints when I visited their schools at the end of the previous term to see classrooms and talk to teachers and support staff. It was a new experience for me to visit schools as a researcher, explain aims of the study to different audiences and be totally reliant on other teachers decisions about content and presentation of mathematics for lessons. A prime purpose of a term's trial was to identify appropriate ways of collecting and analysing data that I could apply in the main study. The first task was to decide for which activities I could make preparation before starting fieldwork keeping in mind knowledge I was expecting to give and gain.



I thought that it was unnecessary to pilot negotiating access into new environments because I had recently organised entry to primary and secondary schools in London for many students and myself. Caroline's teacher could not tell me topics the class would be covering in the summer term but Ms R, Linda's teacher, told me her plans for the first few weeks of the following term. I obtained permission from the publishers to audio reproduce sections of the book from which Linda would be learning about handling data. In my electronic searches for contacts in the UK, I found audio combined with literacy but had no success with audio combined with mathematics. I was obliged to rely on limited past experience to prepare tapes ready for the beginning of the summer term. I visited educationalists, retailers and technicians with knowledge of audio equipment and production including Bradford Talking Magazines, The Confederation of Transcribed Information Services (COTIS) and the Royal National Institute for the Blind (RNIB) but for them recording mathematics was a secondary interest. I chose audiotapes and mono equipment in keeping with advice from the Minister of Education to schools to invest in low cost equipment and not assume that expensive items were superior.

To pre-empt queries, provide a structure within which to work and give me a sense of security at the start I favoured a quantitative approach with results presented in numerical form. I thought that claims would be more convincing if substantiated by empirical evidence to show the need for and benefits of an audio process. Objective methods for observation seemed a safe logical way of proceeding. I foresaw my role as an observer in classrooms concentrating on students who had agreed to help with the research. I was thinking in terms of systematic observation. I would be concentrating on timing students with VI accessing information in print, including visual displays, with and without audio means and comparing their speeds and

levels of achievement with other students with no visual disability tackling the same tasks.

I wanted to know if items of hardware I had selected and recordings I had prepared were appropriate in classes of thirty or more students. I would be searching for evidence that would confirm or disconfirm positive and negative claims made by participants about the whole audio process. I compiled checklists and tables that would be quick and easy to complete whilst I was observing. The procedure I was proposing was designed to generate knowledge from analysis about the potential value of having opportunity to listen as well as look at text and diagrams. I drafted questions to elicit information and conduct formal interviews (See Appendix 3b).

I was thinking in terms of providing a service ostensibly for students but hoped that adults teaching and supporting them might also derive benefits from the innovation. I was uncertain if this would happen but findings from the pilot study might give an indication of whether this was a realistic aim. I planned to make field notes to put observation in context by recording factual data such as dates, duration and time of day and include diagrams showing where students were seated in relation to each other and adults. I drew up a time management plan to ensure that I maximised the amount of data that I could collect and keep control of the overall organisation during the study.

## **Starting the pilot study**

When I explained the purpose of my research to members of staff in schools 1 and 2, I was disconcerted by the general acceptance that underachieving in mathematics was inevitable due to students' visual disability. From my work as a practitioner with Alex (See Chapter 1, p.18) and other mathematically able students, I knew that this assumption could be erroneous and

detrimental to individuals. I was interested in addressing the question of whether it was mathematical education failing students rather than the students failing in mathematics.

I had taken steps to keep expenditure on equipment low and avoid making too many extra demands on adults in schools. This was a period for finding ways of assessing appropriateness of hardware and software and discovering if these might be acceptable in mainstream classrooms.

### *Caroline*

When I first met Caroline, she was in a nursery class of a primary school (South London, mixed, 320 pupils). She was three years old and had lost sight, suddenly, after an operation. She was in year 4, when I asked for her help with a pilot study. Ms E, her support assistant had obtained the Braille transcription qualification. The LEA provided equipment recommended on Caroline's Statement that included a four track audio recorder. Caroline was keen and able to learn mathematics. She used to talking openly to me about her thoughts and feelings but I had not worked with her in a classroom for over two years.

For the first few weeks my role varied between being a complete observer to participant observer in the classroom when I took over, occasionally, as a support teacher to free Ms. E to Braille text requested for other subjects. Mr B's teaching was spontaneous and enjoyed by most students including Caroline. In my 'log' I describe him as "an exceptional teacher with interest and enthusiasm in children as well as in maths" (15.5.98). During the second half of the term I had to work with Caroline out of the classroom for mathematics due to unexpected circumstances. Caroline did not want to use any of the listening devices and found the tape recorder provided for her too complicated to operate. I wrote a factual report, as requested by the school, about Caroline's contribution to the

research (See Appendix 4a). I made audio recordings during withdrawal sessions and a video of Caroline learning alongside her peers before arrangements were changed.

### *Linda*

Linda managed her impaired vision well and won the respect of medical personnel in Guy's Hospital, who appreciated parental support given. She was registered 'partially sighted'. In school she did not want to appear different or talk about the fact that she was depending on only one eye that had some useful vision. She was in year 5 in primary school (South London, mixed, 230 pupils). Linda was co-operative but initially unquestioning. I arranged formal interviews with the headteacher but other data was collected through informal planning and review conversations with teachers and Ms W who was the support assistant assigned to Linda through her Statement. I arranged formal interviews with the Headteacher and SENCO to review progress. They were interested and supportive. I wrote a report as requested (See Appendix 4b).

Changes of teachers and classrooms affected Linda's participation in the pilot study and her opinion about using 'audio'. After four weeks in school 2 I had a chance to change my role from observer to participant-observer. I took over as Linda's supporter when her support assistant, Ms W, was on long term leave due to illness. Linda was accustomed to depending on help from an adult sitting next to her during mathematics lessons. She was not used to working independently. She disliked being separated from her peers but this was necessary because the recorder took up space on tables and she needed to be near a mains plug. Ms R, her teacher, was interested and enthusiastic about the aim of the research and actively supported its introduction into her classroom. She commented that discussing which language to use for recordings was heightening her awareness of this aspect of mathematics. During

whole class activities she began encouraging students to discuss their interpretations of terms in the textbook that were new to them, for example horizontal and axis. I arranged formal interviews with the Head and SENCO to review progress. They were interested and supportive.

I arranged training sessions, whenever possible, with supporters who wanted to be able to make audio-recordings. Scripting was a slow process. I had not found guidelines or examples based on experience for audio reproducing mathematics designed for use in mainstream classes; therefore it was a matter of creating these.

I had begun by filling in checklists and tables that I had prepared but soon discovered that when giving full concentration to completing these it had been impossible to record incidents of interest happening around me. Croll (1986, p.117) discusses "locating observations in time". He acknowledges that when giving full attention to this form of observation it is difficult "to establish context in terms of characteristics of the classroom which themselves require direct observation". I could not make claims to portray reality being experienced by students if I ignored conversations and activities taking place in the classrooms. No one working with either Caroline or Linda seemed to need a mass of statistics to convince them that both students were being disadvantaged through difficulty in accessing the same information as their fully sighted peers. Reading Braille or enlarged text is always slower than reading standard print and quick scanning is not possible. Linda was seldom working without Ms W's input and with an empathetic teacher everyone was aware that visual impairment is an impediment when looking at small print and diagrams. I did not know if such evidence would be necessary in the main study. Foster (1996, p.56) describes the kind of dilemma I faced:

continuous recording is limited in several respects. It can be difficult to use where the type of behaviour of interest changes frequently and rapidly, as is often the case in classroom interaction ... it is also difficult to record more than one variable or category of a variable at a time, unless more than one observer is used

By half term I had decided to abandon the idea of continuous recording. I could not restrict data collection to an objective exercise for collecting factual evidence within an essentially social environment and it was doubtful if this type of data would be necessary for the main study because I was planning to ask for students to be referred to me by advisers for VI working for other LEAs. I concluded that it would be more productive to use the remainder of the pilot study to explore ways of gaining knowledge about contextual issues and obtain insight into individual's intentions through focusing on interactions between people.

Reading Cohen et al (2000, p.9) confirmed my doubts about pursuing a predominantly quantitative approach:

where positivism is less successful, however, is in its application to the study of human behaviour where the immense complexity of human nature and the elusive and intangible quality of social phenomena contrast strikingly with the order and regularity of the natural world. This point is nowhere more apparent than in the context of classroom and school where the problem of teaching, learning and human interaction present the positivist researcher with a mammoth task

I started to list anecdotal incidents that I judged would have positive or negative implications for planning further data collection and serve to support methods being applied or

suggest alternative ways. One of my aims was to find an appropriate way of collecting data and form of analysis that could be applied in the main research, starting in September, to judge how introduction of the audio process was affecting participants. The idea of identifying critical incidents advocated by Tripp (1993) seemed a suitable re-starting point. I give more details of this approach later in this chapter when I discuss analysis. I changed this phrase to 'key incidents' to indicate that the thinking that underpinned the study was to open opportunities to enhance and extend experiences in mathematics for students. I wrote brief narrative descriptions about these incidents after fieldwork sessions before I listened to audio or video recordings that I occasionally made. I used these as suggested by Walker and Adelman (1975, p.129) to "throw light on total interpretation. It is not the incidents themselves that are significant but the meanings that they convey. Recordings should always be used in order to extend interpretation and understanding not to replace them."

My thoughts also turned to Soft Systems Methodology (SSM) (Checkland, 1989). I needed to find alternative methods for data collection and analysis. I recalled the value of applications of this methodological approach in a previous project. I had worked with senior staff in the Inner London Education Authority to set up a system for loaning technological equipment to students in schools. Checkland and Scholes (1990, p.25)<sup>6</sup> explain the value of systems thinking stating that, "to do systems thinking is to set some constructed abstract wholes (often called 'systems models') against the perceived real world in order to learn about it ... the 'soft' tradition creates the process of enquiry as a

<sup>6</sup> I use terminology defined by Checkland and Scholes (1990) in 'Soft Systems Methodology in Action' and Checkland (1999) in 'Systems Thinking, Systems Practice'. These were the main publications that influenced my thinking, in the initial stages of the research.

system." The theoretical detour in the next section provides a glimpse into a form of thinking that can trigger strategic ways of tackling complex problems through using a well-defined intellectual framework. I give reasons why I concluded that SSM was appropriate for this study. In later sections, in this chapter, I explain how I added to or altered methods for gathering and analysing data.

## **Soft Systems Methodology (SSM)**

Failure of the education system is frequently cited as the cause for students underachieving in mathematics. Systemic thinking implies thinking in terms of the whole picture of situations including both people and processes. The challenge is getting to know the complex whole through understanding its parts and the connectivity between these parts in different environments. This is very different from thinking and observing systematically which is the most commonly used adjective derived from the term 'system'. I did not hold the opinion that education is a process with constant, definable properties. This implies that information can be compartmentalised and categorised in a search that will lead to finding one methodological approach that will serve all purposes. I was prepared to use a variety of methodologies.

When planning the pilot study I assumed that my experience-based knowledge of mainstream classrooms was sufficient to prevent social issues presenting problems. It seemed a straightforward matter of improving accessibility but complexity soon became apparent. I turned to theoretical models to assist in conducting "a well-structured and coherent debate about a problematical situation in order to decide how to improve it" (Checkland et al 1990, pp.42-43). For example Checkland and Scholes (1990, p.21) display an order of activities on a diagram. It begins with how individuals perceive the world, and this leads to finding out what



information is yielded from initial analysis and applying this to identify ideas and concepts relevant to the purpose of an activity, in this case researching use of audio materials in mathematics education. From these ideas and concepts new views of the situation are created that result in a different perception of the world. This is a repetitive, ongoing process. The intervention depended on introducing the audio process into classrooms. I was thinking along the lines that it would provide a service for students not treating it as if it was a system about which I possessed all essential knowledge. In social situations that exist in classrooms it seemed improbable that there would be a match between a theoretical model constructed through thinking of possible activities and actions that took place in reality. Popper (1979, p.21) contends the widely held view that, "social situations are more complex than physical ones" claiming that in both types of situations the problem of "inexactitude of prediction" exists. My hypothesis was that audio materials would facilitate accessing mathematics information. I predicted that this idea would lead to increased inclusiveness. My hypothesis guided my observations but I remained open to responding to the unexpected changes in the course of the study, which eventually resulted in a theory of learning emerging that I had not predicted at the outset.

To decide how to proceed I required relevant knowledge about people who would be directly or indirectly affected by the intervention. I wanted to understand and explain why and how their beliefs, values, interests and abilities were affecting their views of reality. Checkland et al (1990, p.20) argue that, "we perceive the world through the filter of - or using the framework of - the ideas internal to us; but the source of many (most?) of those ideas is the perceived world outside." It seemed inevitable that individuals' interpretations of what they experienced would differ from each others and mine.

I decided to put my thoughts onto paper and constructed diagrams known in SSM terminology as Rich Pictures (see Appendix 3a). The purpose of these rough drawings was to represent my thoughts about "structures, processes, relationships and issues" (Checkland and Scholes 1990, p.288) that I believed would be significant in classrooms into which I would be introducing the audio process. I would make additions to the Rich Pictures as the study progressed. I was trying to improve present situations for students and those working with them, not produce perfected, pictorial models for others to peruse.

One of the Rich Pictures shows components in participants' backgrounds that seemed likely to influence their thoughts and action. Other pictures displayed activities and structures that would require consideration in production and use of audio hardware and software items. I was intending to compare my theoretical overviews with observations made in classrooms and how participants perceived, reacted and responded to the intervention. In each situation I would need to take into consideration how unexpected variables might affect the progress of the study. I wanted to leave choice of audio equipment open and encourage suggestions for improving use and production.

I was converted to constructing overall pictures of situations by my experience from the beginning, that data collected about individuals in particular classrooms could not be isolated and analysed without reference to environmental factors. I had to acknowledge and search for external elements that could be

responsible for how participants responded. Holon<sup>7</sup> is a term used in SSM in connection with taking the whole situation into consideration when undertaking activities to achieve stated aims of a system that in this case was a service. I would be aiming "in all areas of study to explore the consequences of holistic rather than reductionist thinking" (Checkland 1999, p.92).

To understand SSM it is necessary to know its origins. Managers faced with demands to explain failures in the field of engineering found the task of resolving problems with people more challenging than testing and presenting results about technical aspects of their work. They knew what they were trying to find out but encountered difficulties with communication and control concerning decision-making and working with others. I envisaged a similar scenario arising in my enquiry.

Checkland favours visual representation. An elegant model is one that adds a dimension of simplicity that helps to make sense of or inform a complex enquiry. It should be "appropriate for the complexity of situations and offer accessibility to what is sitting on paper" (Brown, 2003). SSM is a response to inadequacy of conventional models. A model should not be too complex so it confuses but should assist in addressing issues in highly complex situations. Even during the preparation phase and pilot study this research was far more complex and far-reaching than I had anticipated.

<sup>7</sup> a purposeful 'holon' must have within it, activities and structure concerned with communication and control so that the holon could in principle (were it to exist) adapt and survive in a changing environment ...the description of any purposeful 'holon' must be from some declared perspective or worldview. Checkland and Scholes (1990, pp.24-25) Humans interpret the world in different ways so there is "never only one relevant holon" (ibid, p.27)

Figure 2.1 shows a diagram entitled "The methodology in summary" (after Checkland 1975). Activities in stages 1, 2, 5, 6 and 7 involve taking action in the real world and stages 3 and 4 concern thinking about the real world. Above the line "we are operating in and on the world of reality. Below the line, we are constructing models for epistemological use above it" Checkland (1999, p.249).

Figure 2.1

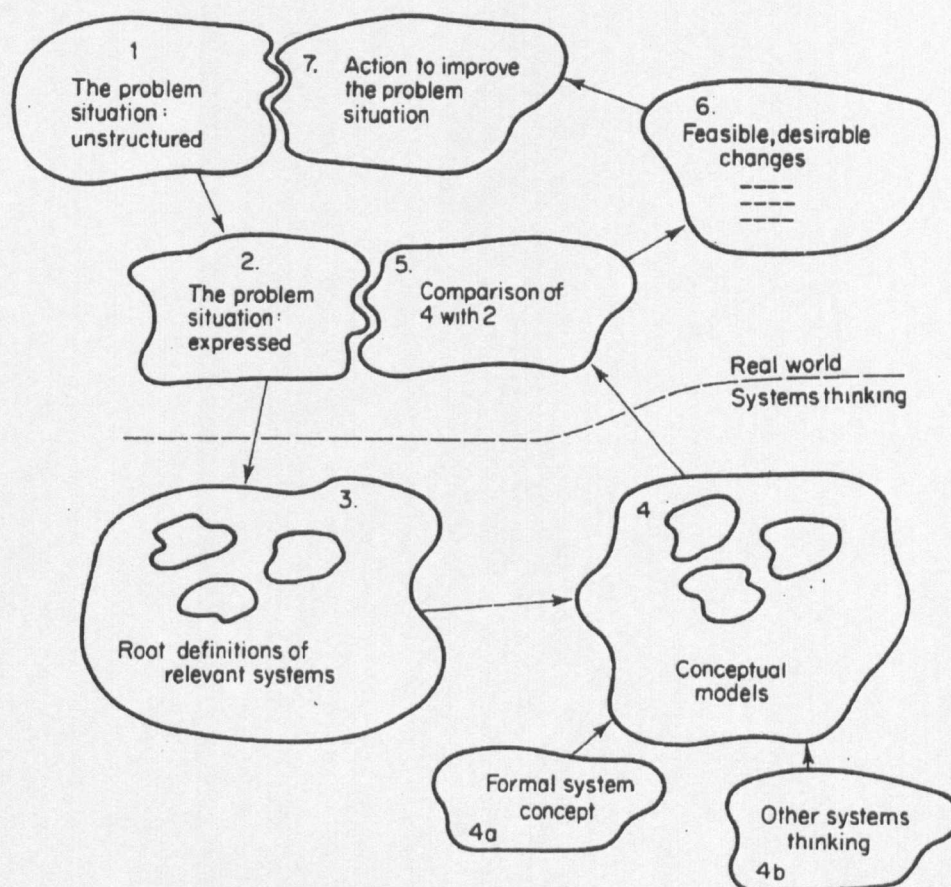


Figure 6. The methodology in summary (after Checkland, 1975).

In his summary on the implications of systems practice Checkland (1999, p.19) states "that the most important systems ideas are emergence, hierarchy, communication and control". He defines the meaning of emergence by describing it in terms of a 'human activity system' that "exhibits properties as a whole entity which derive from the component activities and their structure but cannot be reduced to them" (Checkland 1999, p.314).

He elaborates on the meaning of the term 'hierarchy' to clarify the way in which this word is used related to SSM:

hierarchy theory is concerned with the fundamental differences between one level of complexity and another ... what generates the levels? what separates

them? what links them? ... imposition of constraints upon activity at one level which harnesses the laws at that level to yield activity meaningful at a higher level, is an example of regulatory or control action. Hierarchies are characterised by processes of control operating at the interfaces between levels.

(Checkland 1999, p.81)

Figure 2.1 gives an overview of the activities that I would be undertaking but not necessarily in the order shown. I would be coordinating and monitoring the study but relying on participants to suggest and help implement ideas for improving matters for themselves and others in order to move the whole process forwards. I would be observing situations from the point of view described by Checkland (1999, p.14): "systems concepts are concerned with wholes and their hierarchial arrangement rather than with *the whole*". Whether outcomes satisfied participants would depend on 'communication'; which is another integral characteristic of SSM. "The hierarchically organized whole, having emergent properties, may in principle be able to survive in a changing environment if it has the processes of *communication* and *control* which would enable it to adapt in response to shocks from the environment" (Checkland et al 1990,p.19).

Issues of communication had to be addressed from the outset. Checkland and Holwell (1998, p.238) conclude that "meanings will never be totally agreed: they will always be in a state of flux. Hence what counts as 'information' will never be static, or subject to only one definition, it too will be in a state of flux". I had devoted time in the preparation phase to wording introduction of the research to audiences that would range from students in primary schools to professionals in high-power positions. As an independent researcher I would play a central role in all aspects of the study. I felt that the aspect of

control could present a considerable problem but in the early stages I was uncertain how this would manifest itself or how I would cope with issues that that this might raise. Bignell and Fortune (1984, p.155) define the environment as "being immediately outside the system as regards our mental picture and comprises of things that are not part of the system but do affect the behaviour of the system, or are affected by it". I could not take into account these unpredictable elements of environments, which would remain unknown until I began working in schools. I had to be content with the reassurance that:

the outcome is never an optimal solution to a problem, it is rather a *learning which leads to a decision to take certain actions*, in the knowledge that this will in general lead not to 'the problem' being now 'solved' but to a new situation in which the whole process can begin again.

(Checkland 1999,p.213)

I would be interested in approaching problematic situations from the perspective raised by the question "What are implications of this systems *practice* for systems *thinking*?" This seemed an appropriate way of proceeding based on findings from analysis of data gathered in the first few weeks of pilot study. 'Holonc thinking' as suggested by Checkland and Scholes has not been widely adopted. Maybe without its association with the controversial term 'system' this way of thinking would have received greater accolade. I could not foresee complexities in advance. I would be depending on how all of us who had been involved had perceived happenings in situations. I hoped to gain ideas from reflecting on these perceptions that I could use to reassess how to proceed, methodologically.

To understand my hopes and worldview (in systems terms 'weltanschauung') expressed in this account it is essential to know about my background from which these originated (See

Chapter 1). To understand the worldviews of others that would make transformations meaningful to them, I would need to know their backgrounds and opinions. I would keep in mind observations made by Carter, Martin, Mayblin and Munday (1984, p.13), who stress that soft systems descriptions "do not attempt to represent the original situation precisely or unambiguously because they involve emotional reactions, personal values and shifting expectations". What would be 'meaningful' and beneficial for one participant might be meaningless and inappropriate for another.

Wording the purpose of the study and communicating it to varying audiences was an immediate and essential task when preparing for the main study. At this early stage, I had no inkling of how relationships could be affected by misunderstandings and omissions. I constructed a possible Root Definition<sup>8</sup> describing purposeful activities relating to roles of people with whom I would become involved when the investigation was underway and would assist in working towards desired changes or transformations. Checkland et al (1990) suggest using the mnemonic CATWOE<sup>9</sup> to ensure that each essential element is considered when preparing root definitions and are specified in the wording.

Checkland et al (1990, pp.35-36) explain that:

the core of CATWOE is the pairing of transformation process T and the W, the Weltanschauung or worldview which makes it meaningful. For any relevant

<sup>8</sup> A root definition expresses the core purpose of purposeful activity system. The core purpose is always expressed as a transformation process in which some entity, the 'input', is changed or transformed, into some new form of the same entity, the 'output'

<sup>9</sup> The "CATWOE" mnemonic is introduced by Checkland and Scholes (1990, p.35 Fig 2.8) C 'customers'—A 'actors'—T 'transformation process'—W 'Weltanschauung'—O 'owner(s)'—E 'environmental constraints'. I based my questions on the CATWOE mnemonic and desired aims and changes for this research study.



purposeful activity there will always be a number of different transformations by means of which it can be expressed, these deriving from different interpretations of its purpose.

At the outset I could only theorise about how meaningful introduction of audio materials would be to students and those working with them and constraints that may be imposed.

## Ongoing Analysis

I needed criteria for judging whether and how introduction of audio materials to facilitate accessing print information were extending and enhancing participants' experiences in mathematical education. Popper (1979, p.18) discusses the activities of explaining, predicting and testing, associated with scientific analysis. He concludes that how we analyse data, "depends on *what we consider to be our problem* and what we do not consider". I had been motivated to embark on this research by my awareness of students feeling that they were failures in mathematics. Bignell and Fortune (1984, p.157) suggest that to understand failure it is necessary to identify factors that may be causing problems in order to eliminate them by "tracing them back, assessing the importance of each as a contributor, all the while seeking explanations for features in terms of others".

I used a framework that consisted of SSM properties and principles interweaving systems thinking with systems practice. Examples of activities in the framework that I compiled were: holonic thinking; questioning aspects of communication and control; re-wording root definitions; planning and checking results against the 5Es (Efficacy, Efficiency, Effectiveness, Ethicality and Elegance); assessing situations using the three modes of analyses (Analysis of the Intervention, Social Systems

and Political Systems Analysis). I would be trying to identify and explain influencing factors to inform further methodological planning. Checkland's (1989, p.118) claims that, "an individual can only test a methodology by seeing if he or she finds it useful".

### *The 5 Es (Efficacy, Efficiency, Effectiveness, Ethicality and Elegance)*

The 5 Es raised issues when undertaking ongoing and retrospective analysis of data accumulated during fieldwork. I formulated questions in relation to the purpose and focus of the research:

**Efficacy:** Does the audio process enable accessing?

**Efficiency:** Are minimum resources being used and cost of hardware and methods of producing software appropriate and economically acceptable in classes of thirty students?

**Effectiveness:** Is the audio process extending and enhancing participants' mathematical experiences?

As noted earlier, the initial purpose of the research was to discover and develop an efficient and effective system for accessing print information through audio means. The term effective caused controversy in discussions with professionals. Bignell and Fortune (1984, pp.161-167) define these processes:

one way is to compare the inputs to the system with its outputs and thus to measure its efficiency; the other is to compare the outputs with the objectives of the system and thus measure its effectiveness ... the systems approach disciplines the analyst to look at all of the outputs of the whole system, both desirable and undesirable, and at the same time to search for reasons why outputs that should be present are absent ... the systems approach is free to adopt styles of investigation that are particularly relevant to the problem situation.

Ethicality: Is introduction and development of the audio process ethically acceptable to students and people working with them? Examples of considerations would be to take into account a requirement that "researchers inform all research subjects about what is taking place and all subjects are free not to take part in the study" (Croll, 1986, p.93). I would protect confidentiality by not using participants' real names in reports.

An outside researcher with no sponsor, like others undertaking educational research, must know and fulfil ethical "obligations to participants as well as the research community" (Cohen et al 2000, p.316). Throughout this study I applied recommendations contained in the Draft Ethical Guidelines for Educational Research (BERA 2003). I put into practice the 'Responsibilities to participants' and 'Responsibilities to the Community of Educational Researchers' listed below with how I fulfilled these ethical obligations:

- respect for any person involved;
- researchers engaged in action research must consider the extent to which their own reflective research impinges (see section on Roles in this chapter);
- securing of participants' voluntary consent before research gets underway e.g. I consulted parents, members of staff and students prior to introduction of audio process;
- participants should be able to withdraw at any time;
- best interests of the child must be the primary consideration e.g. students' feelings were respected, views requested and ideas implemented;
- comply with legal requirements in relation to working with school children;

- take all necessary steps to reduce the sense of intrusion and to put them at their ease e.g. I obtained agreement from students and adults before introducing the audio process into classrooms;
- use of incentives to encourage participation ... avoid choices which in themselves have undesirable effects e.g. only incentives in keeping with policy in schools were offered to students;
- researchers must take steps to minimize the effects of designs that advantage or are perceived to advantage one group of participants over others e.g. whenever possible, opportunity to use audio materials in lessons was opened to all interested students;
- confidential and anonymous treatment of participants' data ... ensure that data are kept securely e.g. interviewees were offered copies of conversations that they had agreed could be audio-recorded, names were coded in observation notebooks and pseudonyms used in research reports publicised.

Cohen et al (2000) devote a chapter to discussing 'ethical dilemmas' that include issues of privacy, anonymity, confidentiality, betrayal and deception. Dilemmas of "non-intervention" were difficult to resolve. Initially, the pertinent question was "when does non-intervention become morally reprehensible?" (Cohen et al 2000, p.315). I acknowledged how my presence and involvement might be affecting participants by constantly reflecting on and making explicit my role in situations. When I consciously changed from accommodating to existing conditions and started searching for opportunities to make changes and improvements I was faced with the dilemma of being too intrusive and invading privacy.

Elegance: is the way of putting the audio process into practice aesthetically pleasing? Does it offer a simple, accessible means for complementing mathematical learning?

I reasoned that these questions would expose important issues concerning keeping focused on the beneficiaries of the research, how roles affected relationships and which factors were determining how the study was permitted to proceed. Progressing through stages 5,6 and 7 (see Figure 2.1) would provide some of the answers but not all and would probably raise new problems and questions.

### *Analysis of the Intervention*

Analysis of intervention would be relevant throughout the study. It requires examination of the intervention or interaction in terms of the roles of participants. It requires making explicit reasons why a person decided to intervene in a situation, for whom the intervention is intended and who else is sufficiently interested in the idea to take an active role in assisting to improve a problematical situation under review. Analysis is undertaken with reference to root definitions and "enables a check to be kept on what can be attempted with the resources and time available" (Checkland et al 1990, p.186). There was the possibility that the introduction of audio equipment and materials into classrooms and my presence might be regarded as intrusive and undesirable. I was particularly interested in incidents that indicated that students or people working with them were finding the process helpful or was causing more problems than it was resolving and methodological implications that emerged when role changes occurred.

### *Social Systems Analysis*

Social Systems Analysis focuses on how Roles, Norms, and Values can affect interpersonal relationships. Checkland et al (1990,

p49) explain that, "each element defines and is defined by the others". They go on to explain that:

by role is meant a social position recognised as significant by people in the problem situation ... a role is characterized by expected behaviours in it, or *norms* ... actual performance in a role will be judged according to local standards, or *values*.

(Checkland et al 1990, p.49)

I intended to keep my role under constant review and include a description of how I had participated in incidents identified as critical through ongoing analysis soon after each practical session. How others perceived the part I was playing and made comparisons between their expectations and my reactions and responses, at difficult moments, would determine the type of judgements made about the value of the research. I presumed that most of the personal data I required about participants would be obtained through observation, in particular, listening to impromptu, unguarded remarks and comments. Checkland (1999, p.231) summarises the importance of the three elements, role, norms and values and the interrelationship between them:

neither roles nor norms are fixed, but change steadily through time, sometimes slowly sometimes remarkably quickly ... ascertaining what roles are significant, and discovering the norms associated with them are important parts of systems methodology, as is the discovery of the third element always associated with roles and norms: the values according to which behaviour in a role is judged.

(Checkland 1999, p.231)

## *Political System analysis*

Findings from analysis of data collected during the pilot study indicated that constraints and differences of opinion concerning introducing innovations in schools were many and varied. According to soft systems principles "for the practical purpose of analysis, politics is taken to be a process by which differing interests reach accommodation" Checkland et al (1990, p.50).

Checkland (1999, pp.232-233) refers to organizational problems in which SSM thinking and action were applied over the past decade to address elements of power: "it is important to find out how power is gained, legitimised, held, exercised, and passed on in the situation".

I learnt from experience that it was imperative to analyse how power is deployed and wielded within situations being studied. Relationship between roles, norms and values can be instrumental in determining the way in which power is used and abused. This aspect of the study is discussed in detail in Chapters 4 and 5.

My first attempt to formulate a root definition, below, contains information about who I predicted might benefit or be disadvantaged by use of an audio process; who is initiating and is ultimately responsible for the research; who will be taking part and what are expectations; who could stop introduction and development of the audio process; which environmental elements could create constraints.

*Root definition 1:* A researcher-owned and organised system to facilitate accessing information presented in print for students with little or no sight, by introducing audio equipment and materials into mainstream classrooms, in order to enhance and extend their experiences in mathematical education and assist those working with them.

In SSM terms, the accessing potential of audio materials could be considered as an emergent property of the study. Identifying and researching the separate parts and how they interrelated at different levels would continue to be an ongoing activity. For example parts under review would be separate skills that participants needed to acquire to operate audio hardware and use and produce software. Different types of skills are required at different levels. The nature of the skills increases in sophistication and complexity according to the level at which they operate or are required. Each skill would not be an entity in itself but combined with other skills could possibly form a powerful means for enhancing mathematical education for those striving to read print. Details of necessary skills to acquire and develop for involvement in the audio process are described in chapter 3.

## **Recess 1 Analysis & planning (August 1998)**

After I abandoned continuous timings and completing lists I was able to give attention to recording social interactions and feelings. I had wanted to keep the situation under control during this first phase of fieldwork. I should continue to be engaged in activities to achieve aims stated in the root definition. I hoped that thorough preparation for the main study would ensure that people who possessed the power to stop the transformation would not exert this.

The fact that feedback from participants was at the core of this study resulted in communication, as anticipated, becoming a major feature of the research. I wanted to know the views and ideas of students and adults. It was evident from the reactions of Caroline and Linda and their supporters that the range of choice of equipment offered was too limited and needed to be extended. This applied to items for making recordings as well as use for listening. Composing scripts had been a time-



consuming task that would need to be carefully monitored to ensure efficient use of time in the next practical phase.

I did not predict ethical difficulties because I was requesting criticism of ways in which audio technology was being introduced and used in classrooms. I was not asking for comments about either the education system, other students or adults. My interest was in how they perceived their experiences of using a complementary audio medium within classrooms. An overview of methodological issues that arose in schools 1 and 2 is given in the following section but more detailed descriptions are provided in subsequent chapters. I had no chance of checking or comparing views of participants in either of the schools after the term ended. Unplanned events and poor communication complicated the amount and type of data that I was able to collect in school 1.

The immediate task in this first recess was to write reports on the pilot study including Caroline and Linda. I used Analysis One to analyse incidents described in the following summary that occurred after I started applying an SSM approach in the pilot study. I had listed sixty incidents of interest in my field notes related to the questions I drafted and issues I had expected would arise. I wrote a narrative account as well as the formal reports requested by schools and found this acted as a debriefing exercise that helped to clarify my thoughts and feelings. I was overwhelmed by the amount and variety of data that I had accumulated. Foster (1996, p.41) warns that this can happen with audio/video recording: "the researcher may be swamped with a large amount of data far beyond what is necessary or possible to analyse." I was reassured that I was not alone in overestimating the amount of data that I could handle but recently when writing this account I have found reading first impressions and listening again to tapes recorded in schools 1 and 2 interesting and enlightening. It was

certainly not wasted effort. The advantages and disadvantages of video cassette and sound cassette recordings are itemised by Wragg (1994, p.16) and are discussed in chapter 3.

The insurmountable problem of accurate measurement that I had encountered and arguments put forward by experienced practitioners and researchers convinced me that it would be unwise to make claims that I had discovered correct ways of proceeding on the grounds of effectiveness. Also I was uncertain about the type of outputs that would result from introducing the audio process. If I pursued this path I foresaw danger of undermining the validity of all future claims. I would not have any idea of outputs until I got to know the people who would be involved and the environments in which the study would be taking place.

I had assumed that, in schools where I was known, there would be no conflict of interests between students, those working with them and myself. I had consulted parents, students and adults likely to become involved. The idea behind the research was to offer a complementary way of learning, not criticise mathematical pedagogy. I thought that I had explained to everyone about possible implications of the intervention prior to introducing the process into classrooms. No one questioned me or expressed reservations about the research but I sensed resentment from some adults about how I was putting ideas into practice. For example my request to work occasionally with support assistants out of the classroom was not readily granted. I explained that it was necessary for them to know the potential of the equipment and acquire skills to take over the process eventually. No one had disputed the desired outcome, but establishing collaborative constructive working relationships to facilitate the accessing and handing over process was not accepted with any great enthusiasm. In schools 3 and 4 I should need to state likely implications more

emphatically and in greater detail from the start. This was a learning experience. It had been possible to obtain agreement on ends but there can be sharp divisions about means. As the initiator of the research I took responsibility for final decisions. I planned to continue to respect confidentiality and differences in the main study. The audio process was orientated towards individual differences and therefore diverse ideas, views and ways of taking part in activities would be encouraged and valued. The original ideas that emerged during withdrawal sessions with Caroline convinced me that I should be searching for opportunities to encourage creative aspects of teaching and learning as well as concentrating on the process of accessing print materials. Both students and adults had communicated their appreciation through increased interest and enthusiasm when they realised their ideas had been taken seriously. This way of interacting was worth replicating but I hoped that it could happen inside classrooms.

### *Critical incidents*

In this section I give examples of incidents that occurred in practice and affected my response to questions listed prior to the pilot. I reflected on all aspects of what had happened during the past three months. I do not claim that findings represent, accurately, participants' views because of the short duration of the pilot study and the unexpected incidents that arose in schools 1 and 2. I would like to have had the opportunity to have gone back and spent more time in these schools and "debrief participants at the conclusion of the research" (BERA 2003, p.6).

I started analysis by questioning the significance of incidents that I had listed. I was influenced by notions of what constitutes a critical incident, moment or event and the possibility of misleading others by over-using this method to justify claims to understand what had happened in reality. As

Tripp (1993, pp.25-26) explains, there are "two stages to the creation of a critical incident: first some phenomena is observed and noted, which produces a description of what happened ... the critical incident is created by seeing the incident as an example of a category in a wider, usually social context." For example I identified Caroline's reluctance to use listening devices as being a defining event that changed her attitude from enjoyment and interest in using audio means to disinterest and rejection of this medium. At the time this had not seemed surprising but in trying to explain why she reacted so strongly, other factors came to light concerning relationships with peers and myself. The headphone incident was critical for Caroline because she was feeling socially isolated. This alerted me to the need to research alternative accessories as well as recorders and to continue to reassess the technological aspect of the investigation over the following years. From Linda's experiences it was evident that recorders needed an alternative source of power. I had not thought about this problem until a safety issue arose.

The moment when Ms R remarked on her increased awareness of how she was utilising mathematical vocabulary opened up a different aspect of the research. It was the first incident that indicated that adults as well students might benefit from the innovation. I discuss in detail in later chapters about other incidents that Woods (1998, p.42) describes as moments of "exceptional insights" and "new directions for the research." I learnt from this first phase of fieldwork that making detailed plans based on many years of practitioner experience and taking into account the knowledge of others does not guarantee that all data required will be identified and collected as intended. Woods (1998, p.54) gives sound advice "to develop and maintain a state of mind which will enable us to turn apparent adversity to good account". The work out of the classroom with Caroline and Ms E provided much useful knowledge that was invaluable

when planning for purchasing additional equipment and producing better recordings.

Tripp (1993, pp.98, 111) cautions that collecting critical incidents to aid understanding can mislead rather than inform

as data critical incidents are mere fragments, minute samples of the complex plethora of everything that actually occurred. Further, they are usually highly emotionally charged and more often than not uncorroborated at the time and then reconstructed long afterwards ... others may find our analysis partial, ill-informed or outright wrong; and the explanations we favour indicate much deeper underlying mental constructs that we value.

It was essential to recognise and acknowledge the drawbacks of attaching too much unquestioning importance to incidents that I had identified as critical. I needed to continue to make explicit my interpretations and understandings and how my personal history and beliefs may be influencing decisions in this particular study.

I would not be attempting to replicate all methodological strategies in the next phase, knowing that findings from the pilot study may be unreliable, but using these as guides would help to decide which methods to repeat or reject. Tripp (1993) recommends formulating questions and linking these to kind of judgements being made that relate to the aim of the research and people involved. I found his diagnostic questions useful to guide analysis of an incident that occurred: "What happened? What made it happen? What does it do? What does it feel like? What does it mean? Why did it occur?" (Tripp 1993, p.27). I had already discovered that the meaning of an incident to me did not always coincide with its meaning to others. At this stage I was interested in its significance to making plans for the main research study.

## *Observation*

On reflection I concluded that the type of observation that I had undertaken during the pilot could be described as "semi-structured" (Cohen et al 2000, p. 305). I had "an agenda of issues". I was aiming to "gather data to illuminate these issues" but I did not have "observation categories worked out in advance". I had found it impossible to obtain a rich enough picture of what was happening in classrooms depending only on observation. I concluded that the way in which I had conducted the pilot study was not in complete accordance with any accepted form of educational research design.

Obtaining participants' interpretations of events and language would be as crucial as observing in this inquiry. I had hoped to start gaining knowledge that I would be able to use, as the study progressed, to judge how other students' mathematical experiences were being affected by introduction of audio materials for accessing print information. My teaching experience had been predominantly in secondary schools and perhaps this partly explained why my predictions bore little resemblance to the reality that I found in primary schools. Neither Caroline nor Linda were convinced that a complementary audio-recorded medium was helpful to them. The main enthusiast was Caroline's SA, Ms E. I consoled myself with thoughts that the complications that arose in schools 1 and 2 were unusual and could not have been foreseen.

I would like to have selected two students randomly as case studies for the main research but due to the initial population specified and practical problems encountered in the pilot study this was not feasible. Mohammed and Thomas warranted high priority on the list of ten possible participants referred to me by schools and VI advisers working in other London boroughs. I visited schools 3 and 4 before the term finished. Mohammed was partially sighted and about to begin secondary education.

Thomas was nearing the end of his primary education and there were concerns about his lack of confidence and progress in mathematics. I decided to stagger starting to work with them so that I could establish the audio process in one situation before starting it in another. I was looking forward to introducing the innovation into schools whose policies stressed inclusive education. I would have sufficient time to get to know the students and their working environments before gradually handing over the process for people in the schools to continue.

### *Case study?*

I had to give full attention throughout lessons to Caroline or Linda in order to gather data through observation on how they were reacting and responding to using the audio items and the effects this was having on their ability to fully participate in mathematical activities in classrooms. Simons (quoted by Bassey 1999, p.36), writing on the value of case studies in research, welcomes the paradox between singularity and the search for generalisation:

one of the advantages cited for case study research is its uniqueness, its capacity for understanding complexity in particular contexts. A corresponding disadvantage often cited is the difficulty of generalising from a single case. Such an observation assumes a polarity and stems from a particular view of research. Looked at differently, from within a holistic perspective and direct perception, there is no disjunction. What we have is a paradox, which if acknowledged and explored in depth, yields both unique and universal understanding.

I was interested in getting to know the uniqueness of each student but I also wanted to present their stories for other

practitioners, who like me might be searching for examples of practice on which to base their own research studies. Naumes and Naumes (1999, pp.70-71) discuss some of the advantages and disadvantages associated with "case research":

it has developed as a means to develop, test and extend theory ... it is also valuable due to its ability to demonstrate the interaction over time of actions and decisions with values and environment factors ... it allows the researcher to place the research in the context in which it naturally occurs. The disadvantages of case research is that it is difficult to replicate, due to the variety of extrinsic factors that are present in any real setting. Also it is difficult, time consuming, and expensive to implement. Its validity can be called into question, because it relies on the observations of a potentially biased observer.

When I embarked on the study I decided that the advantages of case research outweighed the disadvantages. I was setting out with a tentative theory about use of the audio process that I wanted to explore in practice and if possible extend. Environmental factors would unavoidably affect what happened. I expected to spend many months investigating use of audio materials with Mohammed and Thomas and adults teaching and supporting them in lessons. One of the features that I hoped to develop was adaptability so that the process could be introduced to students in other schools. Expense would not be a problem working with only two individuals. I intended to keep in mind the possibility of being biased when noting data and acknowledge this, explicitly, at all times. Due to the way that I decided to continue with the research, triangulation through using a team of multiple observers was not feasible. I was aware that my role had affected working relationships with



participants in the pilot. I hope that my autobiographical account in Chapter 1 will assist readers to form their own judgements about claims that I make.

I did not regard students as subjects or objects of my research. I wanted to work with them. Changing my title from advisory teacher to researcher and adopting a less formal approach had not led to collaborative working relationships in schools where I was known. This affected the type of communication possible between myself and contributors and consequently the information made available and willingness with which this was given. They were accustomed to asking me for advice and were unable to change their relationship with me in spite of my efforts to be treated as their equal.

I learnt from the pilot that I needed to devote full attention to an individual for an entire lesson in order to gather sufficient, in-depth data to understand a student's interpretations of activities and conversations in the classroom. Gall, Borg and Gall (1996, p. 574) refer to this way of recording findings from data collected, as "thick description of the participants and contexts that comprise the case". They advise using triangulation "to validate a case study finding by drawing on corroborative evidence ... triangulation helps to eliminate biases that might result from relying exclusively on any one data-collection method, source, analyst or theory".

### *Triangulation*

I was convinced by the findings from analysis that I should be unsuccessful in a search for one set of methods that I could apply to address all issues central to the research within the unpredictable, complex social environments in schools. I was beginning to understand why practitioners and academics advocate triangulation, "there is clearly no single method of

inquiry that should be employed in educational research" (Keeves 1997, p.278). Denzin (1988, p.512) agrees with this view:

the most fruitful search for sound interpretations of the real world must rely on triangulation strategies. Interpretations which are built on triangulation are certain to be stronger than those which rest on the more constricted framework of a single method.

In School 2 it was not until I analysed my observations in a lesson and my conversations with both Linda and Ms W that I understood the reason for Linda's confusion when she had talked about a picture in a textbook that she had listened to being described on audiotape. Stake (1985, p.282) emphasises that employing triangulation in case study research implies "various ways of cautiously looking again and again, plus the commitment to seek deliberately to disconfirm one's own interpretations". I would have to resist the tendency to always look for supporting evidence. It was tempting to discount negative comments and events when concentrating on trying to make a positive contribution towards mathematical education. I was reminded of the value of keeping a balanced view when investigating any form of systems failure. An accurate assessment of what lay ahead in the next phase was forecast in Bassey's (1999, p.44) comment that, "interpretation is a search for deep perspectives on particular events and for theoretical insights. It may offer possibilities, but no certainties, as to the outcomes of future events."

I intended to replicate ways that I had found appropriate for introducing and developing use of audio hardware and software in the pilot study but not repeat the same mistakes. For example I had evidently not made my role in the classroom clear to all students and I had not offered an adequate choice of listening devices. I was inclined to continue employing SSM

strategies that had proved helpful and supplement these with means traditionally linked to other methodologies for tackling the task of obtaining feedback from participants in order to take the investigation forward. Reading that echoed my own sentiments about the possible advantages of a multi-method approach gave me enough confidence to start examining a variety of methodological strategies for future collection of data, within a case study framework.

## **Reconsidering SSM**

On the one hand questions raised about 'effectiveness' caused me to wonder whether I should abandon SSM, given the nature and origins of my research. On the other hand the thinking that underpinned the research was that it would take place in classrooms that are essentially social environments. Difficulties had arisen in trying to complete Rich Pictures. I had been unable to see or hear many of the interactions in classrooms because I was completing checklists and tables. I was doubtful if a longer spell of time would have solved these problems in Schools 1 and 2. I had found the rich pictures and the CATWOE framework helpful as an aid to keeping an overview of the whole situation and to comparing how abilities, attitudes and accomplishments of participants were developing. It was evident that I could not substantiate claims by measuring times and working speeds to show effective use of audio materials. I wondered whether I should avoid all methodologies that advocated evaluating, determining, and searching for evidence to substantiate claims for finding one truth or way of collecting and analysing data. I was no longer expecting to find an ideal set of equipment that would suit every student but I still believed that numerical data might serve to support claims made that students' knowledge was being extended by the audio process. Stronach and Torrance (1995, p.285) write about researchers "trying to work within systems"

but at the same time attempting to distance themselves from "notions of neutrality or value freedom and the myths of objectivity". Maybe I was attempting an impossible dream.

At this point I was confused and unsure about how to proceed. I felt that my familiarity with the SSM approach helped to overcome a weakness cited by Clegg and Walsh (1998, p.231) "that the 'language' and terminology of the method can get in the way". But I was concerned that the terminology could divert attention away from the aim of the research. I was not sure that I should totally abandon all thoughts of collecting statistical evidence. I could foresee possible problems in the investigation relating to another criticism made by Clegg and Walsh (ibid, p.231) that "the method does stipulate that change is only made where agreement is reached, in particular that the changes are both systematically desirable and culturally feasible." Disagreement about when and how Linda should use her recorder in the classroom in year 6 arose but remained unresolved when the pilot study ended. I was not optimistic that there would ever be an amicable agreement due to strongly held opposing views. Frederickson (1993, p.2) takes a positive stance that more closely mirrored my own: "as a cyclic learning process the methodology as described is essentially neutral. Any use of it will not be. It will be radical or reactionary depending on the user and the situational constraints." I had been given a fleeting glimpse into how situational constraints could limit the ways in which the methods and principles of SSM can be applied in schools. I planned to focus on how to move the study forwards not on what the system should produce.

In Schools 3 and 4 there would be no pressure on time taken to get to know people and existing conditions. I would not pre-determine my exact role or make such structured, rigid plans for observation. I would accommodate to what was happening in classrooms, review and make plans after each session, noting

issues to discuss with participants that would help me judge, initially, when and how to take audio items into classrooms and subsequently how to develop the process. Thoughts that were tumbling around in my mind concerned: which type of data would be most helpful; which other methods were worth considering and why; which principles and methods borrowed from other methodologies would supplement and complement ways already tried for collecting and analysing data; which roles would I probably need to adopt; how should explanations about my presence and role be worded and presented to different audiences; what were expectations about findings from this research, for example how might use of audio recordings affect learning in the future.

### ***Type of data***

The type of data required, initially, was determined by the need to get to know people and existing situations and subsequently to interchange knowledge and skills to enable easier accessing. Equipment that I had purchased and ways of scripting and recording explored over the past nine months were unlikely to suit all listeners. I required informed advice that I had been unable to obtain in the UK. I pinned my hopes on contact with people in other countries who could suggest additional or different ways of developing the audio process for mathematics that I had tentatively started. I was under no illusions about finding an ideal recorder, accessories or the best way for audio reproducing mathematical information. I was not searching only for evidence to show how an audio process might benefit participants but also looking for incidents that illustrated ways that it could adversely affect users. Time spent in Australia offered opportunity to extend my knowledge about audio production, items and learning to listen.

Swallow and Aitkin (1982, p.120) gives credence to giving attention to developing the ability to 'listen'. She asserts

that, "no child should be expected to understand fully what he has heard on a cassette tape without prior instruction in auditing skills". 'Auding' is the art of extracting information when listening to audio-recorded speech. It differs from listening to general conversation or to adults explaining mathematical topics. Varying speed, pausing speech as listening to information and explanations again is possible. Memory plays an important part and students can be helped to improve this for themselves. It was evident, in the pilot, that all students', adults' and my own 'auding skills' were underdeveloped. I talked to experienced narrators in Brisbane where a Narrating Service has been operating for over twenty-five years and delved into books in libraries in Queensland, Canberra and Sydney. Learning, from applying and developing knowledge I acquired in this summer holiday recess would still depend if people were able and willing to communicate how introduction of hardware and software into mainstream classrooms was affecting them. The feedback during the pilot had been helpful but use of audio in classrooms had been severely restricted. I had noted preferences for positioning recorders and types of ear/head phones for listening but I wanted to lengthen the list of hardware that may be appropriate in primary mainstream classrooms and start to get to know which items could be suitable in secondary classrooms. Before leaving Australia I purchased a small Sony recorder that was not on the market in the UK.

I began by re-thinking how I would obtain opinions in the next phase and my role in different environments. I had been surprised by the variety of answers given to questions that I presented formally or informally depending on the interviewee and the setting. Ms E responded openly and easily to all verbal questions but others tended to be more at ease if conversations started with direct questions and these were followed with prompts and reassurance that their replies were valued. Formal

questionnaires seemed to pose a threat to all respondents. Teachers resented extra paperwork and were overwhelmed by the prospect of piloting the NNP. Support assistants were worried about completing the sheet incorrectly. Asking students to read yet more print was disadvantaging them further, as they were still in the early stages of learning to listen to recorded material. I was undertaking a study related to mathematics generally associated with measurable evidence but most of what I observed could not be measured.

Within a matter of weeks I had gained greater appreciation of the complex nature of reality that exists in schools today. The difficulties that unpredictability and role confusion can create for gathering data became apparent. When I visited schools previously, staff were accustomed to asking me for advice, requesting more resources and impressing me with how they were including students both academically and socially. They were unable to suddenly change to working in partnership with me as a researcher.

I decided I would set out with the idea of getting to know the whole picture through observation and interviews, gathering relevant data from schools and homes and not restrict data collection to events and dialogue within classrooms. I would concentrate on adapting to the same conditions and environments in which students were experiencing mathematical education. I needed to understand people's different perspectives and preferences. I had added components and links to Rich Pictures during the pilot. I wanted to avoid simply making additions to models and comparing them or constructing a paradigm that might, mistakenly, be assumed to be a prototype that would produce the answer for finding the ideal methodology. I was aware of the tendency to presume that ways of working with one student with visual impairment can be generalised to all individuals similarly labelled.

## *Recording data*

I planned to write accounts in narrative form instead of impersonal reports and analyse incidents soon after I noted them, including feelings, strategies employed and plans for subsequent sessions. As well as putting ideas into practice in September I should be writing up case studies. I was interested in the observation made by Gall et al (1996, p.580) that "the two primary characteristics of *reflective reporting* are of literary devices to bring the case alive for the reader and the strong presence of the researcher's voice in the report" (their emphasis). This method appealed to me with the proviso that neither literary devices nor my voice drowned the voices of other contributors.

I wanted to know the thoughts and feelings of all involved in critical incidents but I would need to be more selective about the type and amount of data that I audio recorded for the purpose of obtaining background details about participants and ambience in classrooms. Using a small recorder was less intrusive, but without a directional microphone, recordings of conversations in noisy environments were difficult to hear. I would have to consider if time taken to transcribe tapes would be more profitably spent in producing better quality and a wider range of recordings of mathematical information. I had found out for myself that delaying undertaking reflection-on-action could result in unreliable analysis of incidents identified as critical. I needed to consciously allocate time to think and reflect immediately after each fieldwork session.

I was faced with the prospect of extracting relevant information from the mass of data collected in order to gain knowledge about which methodological strategies would be appropriate to apply in six weeks time. I decided to examine incidents looking for commonality and links between them. I grouped these under sub-headings to assist wording questions



that might provide sound starting points for planning the main research. I found that "creating categories, subcategories, and discovering their links", as Ely et al (1994, pp.145-146) describe, ensured that I kept the focus of the research in mind as I analysed data with the aim of deciding which methods I should change, continue or trial. I was not intending to start the main study by trying to assign incidents to predetermined categories but this way of handling data convinced me that it was better to undertake ongoing analysis instead of waiting until phases of fieldwork finished. I used colour coding and notes in margins as I retraced my path back through the field notes and tone indexed audio recordings of interviews. I reviewed video recordings several times to add details about body language and activities in the classrooms that I had missed.

Findings indicated that ways of introducing the innovation and obtaining feedback from participants had been unsatisfactory. Important elements of data were missing or needed to be checked again. Lack of time could have been a cause but failure to address these issues, now, could undermine claims made in the future. I needed knowledge about alternative approaches with the idea of trying these out in practice to discover whether they might be appropriate to supplement or substitute strategies I had already tried. The themes that I identified during analysis that required attention from the outset were: 'interdependence of theory and practice' in action as well as in planning, 'communication' for sharing knowledge and ideas and 'collaborative working' with participants to develop and improve the audio process in response to input from them.

Guba and Lincoln (1989) pose a "critical question" about methodology that I felt was pertinent to my study. They ask whether their

analysis captures its essential features. We leave the reader to decide how well we accomplish that

goal. At the outset it is also important to distinguish between inquiries that are intended to add knowledge or understanding in some significant way and those intended to assess some state of affairs.

(Guba and Lincoln 1989, p.161)

I would be entering unknown territory in September. Even in familiar environments I had required more background information about people and schools than I possessed and unexpected events had affected what was possible in practice. I would need an overview in as much detail as possible of existing situations in classrooms, before I could contemplate making claims that I could add, significantly, to my own or others' knowledge. In deciding if I should continue or change methodological approaches I was influenced by my intuitive feelings, personal philosophy and practical, past experiences. I would always be the ultimate decision-maker about which incidents were identified as critical and how I should apply strategies from other methodologies. My immediate task was to look at methodologies that would enable me to address issues about *how* and *why* methods in the pilot study had failed to work. Communication would be a central theme throughout the study. If this research was to contribute to present knowledge concerning full participation in mathematical education I must meet the challenge of establishing means of communication to enable me to obtain feedback about use of the audio materials. I had to find ways for developing the audio process in a form acceptable and of value to participants in their classrooms.

## *Role*

In Schools 3 and 4 I would be an unfamiliar figure although as the individual introducing the innovation I would inevitably play a major role. I hoped to capture and portray whole

pictures at particular moments, without being always thought of as the "knower" (Kincheloe 1991, p.26).

Denzin and Lincoln (1994, p.4) distinguish between different aims of researchers: They write that qualitative researchers

seek answers to questions that stress how social experience is created and given meaning. In contrast quantitative studies emphasize the measurement and analysis of causal relationships between variables, not processes. Inquiry is purported to be within a value-free framework.

I knew that my opinions and judgements would not be value-free and these would include decisions concerning continuing or changing methodologies now or later in the inquiry. In preparing to change tack for the main research, I noted the warning given by Kincheloe (1991, p.71) that, "the variables with which the social researcher is forced to contend dispel any illusions of methodological simplicity of outcome and applicability". I had yet to discover the degree to which this would be an apt description of this research study. I anticipated meeting conditions in the main research that would equal and probably exceed the complexity of those that I had encountered in the pilot. Applying what I learnt from findings from the pilot and plans made during this recess would be open to change.

I could only surmise about my role. I intended to respond to reality in different situations. I had already experienced how difficult it could be to change roles within environments where I was known. This time I should be an unknown outsider. I had no inkling of how this role change would affect the type of relationships that I would be able to form with participants. I was looking forward to a fresh start in schools 3 and 4. First, I would need to make the aim of what I was doing clear to students as well as adults.

I was not intending to impose use of audio on anyone. In the main research I expected there to be an even greater range of opinions and ideas. I had gained confidence as the pilot progressed and reflection during this recess reinforced my decision not to attempt to retain control at all times. I would start by accommodating to conditions with the hope that this would enable me to empathise with students' thoughts and reactions in mathematics lessons. I had collected relevant data on use of audio items and recordings in the pilot but too little on the feasibility of the process in inclusive learning settings. I had gained greater insight and understanding of my own limitations and concluded that a more flexible and varied approach when collecting data would be a better way of proceeding.

The problem, as I saw it, had been that organisation in classrooms in Schools 1 and 2 dictated that I was mainly an observer. I thought that I could rely on scientific observation methods but found that I was distancing myself from students and treating them as subjects instead of taking an ethnographic role as a participant observer with its inherent advantages and disadvantages. Woods (1998, pp. 36-40) gives examples of "role conflict" that he encountered during his many years as an insider, ethnographic researcher in schools. I had been aware of conflicting roles in the pilot study. Linda's support assistant was anxious to demonstrate that she could not be replaced by audiotapes. I had made sure that students knew that I consulted and respected their teacher's agreement or confirmation in instances when I wanted to try new ideas or answered their queries. Ultimate responsibility lay with the subject teacher.

As I reflected on my actions during analysis I realised that I had omitted making explicit my respect for support staff and how I valued their contribution to the research and assisting

students assigned to them. (I was interested that Caroline's SA felt sufficiently secure in her post to adapt to trying different ways of working.) I predicted that that if I rectified this omission in the main study there would be a good chance of preventing participants misinterpreting my roles in classrooms.

## **A Hermeneutic/Interpretive approach**

As I shall explain a hermeneutic/interpretive approach appeared to offer ways of supplementing SSM to open lines of communication. To understand participants' perspectives on how an innovatory audio process was affecting their mathematical experiences from their point of view, I would need to get to know relevant, past and present background details in their lives and their aspirations for the future. Carr (1995, pp. 81-83) discusses the strengths and weaknesses of an interpretive approach:

the major strengths of the interpretive approach derive from its firm insistence that educational research must be rooted in the concepts and theories of educational practitioners ... the interpretive approach, though concerned to expose the structure of rationality informing educational practice, refuses to recognise any evaluative criteria in terms of which this rationality can be appraised. And by so insulating the self-understandings of practitioners from direct criticism, the interpretive approach effectively eliminates the problematic character of the practice it seeks to portray.

My theories and concepts concerning use of an audio medium in mainstream were based on my recent experiences in Schools 1 and 2. Taking into account crucial weaknesses of this approach when I entered new environments would be important. I had

preconceptions and beliefs about situations and people based on first impressions before I introduced the audio process into classrooms. When analysing incidents after the pilot study ended I discovered that relying on interpretations made on the spur of the moment can be misleading. Corroboration from others involved in incidents is essential. For example, in Linda's school I interpreted the SENCO's reluctance to continue to communicate with me as personal criticism, but a few weeks later she revealed that this was due to managerial re-organisation in the school and the stress of additional responsibilities assigned to her. In future months I was thankful that, at this stage, I had gained some insight into how misinterpretation can easily result in misunderstandings that can adversely affect further interactions with individuals. I was determined not only to accept criticism and challenges to the authenticity of my interpretations in the main research but also request these.

I had underestimated how social aspects could affect a seemingly straightforward investigation into curriculum access. Usher (1996, p.18) states that "in social research, knowledge is concerned not with generalisation, prediction and control but with interpretation, meaning and illumination". Undertaking in-depth studies of individual students would entail communicating mathematically and conversationally with each other. This implied that there would have to be agreement on the meaning of words and action. Until I got to know individuals involved I could not assume that they possessed the necessary skills for speaking, listening and interpreting what they saw or heard. I could not predict to what degree applying methods borrowed from an interpretative methodological approach would be 'illuminating' but I was determined to find out which strategies would be worth trying to develop communication and keep lines open and accessible to all.

Making predictions and trying to maintain control in the pilot had resulted in a blinkered approach. I had been unwilling to be deterred from my objectives. I anticipated that in the main study when talking to people their interpretation of words and events and mine were unlikely to tally. There would be as many interpretations as there are many truths and inclusions. It would be a fruitless task searching for one interpretation acceptable to everyone. I should be asking for participants' help and therefore they must understand the meaning of my words and I must understand theirs. The exposition on understanding written by Gadamer (1975, p.58) influenced my thinking,

understanding is primarily agreement or harmony with another person ... understanding each other means understanding each other on a topic or the like ... and if two men understand each other independently of any topic, then this means that they understand each other not only in this or that respect, but in all essential things that unite human beings.

I was uncertain whether I should reach the second state of harmony but arriving at understanding on topics would be vital for deciding how audio recordings were scripted and how useful they would be to listeners. My aspirations were that the insight I gained from reflection and rigorous ongoing analysis after fieldwork sessions would enable me to form a more flexible, methodological framework for planning purposes and taking action. I was not considering compiling lists of practical implications and advice for others but rather utilising findings to move forward methodologically.

I wanted to minimise the risk of acting as a kind of ventriloquist and unintentionally distorting or hiding the voices of people on whom I was relying for feedback. The messages I conveyed back to contributors would depend on how I selected and presented their input. I wondered how I could

avoid distortion in recounting verbal communication that could result in misinterpretations. One way would be to audio or video record complete conversations, as I did on a small scale in the pilot, and refer to these as reminders when analysing incidents. Important features had come to light that were not recorded in my field notes, for example tone of voice and body language that accompanied words spoken and portrayed a more representative overall picture than written notes alone. A sensitive area would be cultural differences in use and interpretation of language employed by contributors.

The colloquial and mathematical language of students would be likely to differ from words and phrases used by adults especially those who held high academic qualifications in mathematics and expected others to be similarly dedicated to the subject and its terminology. Gadamer (1975, pp.404-405) confronts the controversial issue of mathematical language, "artificial languages, such as secret languages or systems of mathematical symbols, have no basis in a community of language or life, but are introduced and applied only as means and tools of understanding." The process of communicating the meaning of mathematical symbols in meaningful, understandable language to students through an audio medium would become a major challenge in the years of research that lay ahead. I discuss how this challenge was met and outcomes in later chapters.

I formulated questions originating from experiences in the pilot study, as starting points for gathering data that would take individuality into account and may help explain participants' particular versions of reality: Do students and adults possess the necessary skills and experience to understand and apply mathematical knowledge to the level required in schools? Can they communicate their thoughts to others? Which strategies encourage participants to communicate? On what grounds will interpretations of events and dialogue and



ideas suggested be accepted or rejected? What is the motivation to learn? How do emotions affect ability to learn? What are the interests and aspirations of adults involved in the study? Are they willing to collaborate and take an active role with a researcher, unknown to them, visiting the school? How can I get to know conditions that exist in classrooms and the school? Which sources of information concerning audio technology, inclusiveness, mathematics and methodology will be most useful? To what extent can I manage to relinquish complete control of the situation and judge when and how to intervene? Is practice being supported or contradicted by existing theories published by other practitioners, researchers and professionals? How can I get to know actual conditions under which students are being expected to learn and if their differences and preferences for styles of learning are being valued and acknowledged in practice? How is introduction of the audio process affecting disadvantage due to accessing difficulties? How is deployment and use of power influencing what is happening in reality? Why was an event or interaction identified as a critical incident? Which roles did I take and why in stories of incidents described? What did I learn from analysing the incident? What was the significance of a reflective approach applied throughout the study? Are there links between incidents and did common themes emerge? How do I intend to incorporate findings in immediate and longer term methodological planning and practice? Could this study be replicated in other contexts and predictions made for probable outcomes?

Being forewarned about possibilities of being misled unintentionally should give me a greater chance of developing relationships leading to "understanding each other independently of a topic" (Gadamer 1975, p.158). This type of understanding would facilitate open communication and should lead to better harmony in decision-making. Habermas (1987 pp.400-401) recommends getting relevant "background knowledge"

in order to understand an individual's interpretation of situations:

It is only under the pressure of approaching problems that relevant components of such background knowledge are torn out of their unquestioned familiarity and brought to consciousness as something in need of being ascertained ... if the objective occasion arises for us to arrive at some understanding about a situation that has become problematic, background knowledge is transformed into explicit knowledge only in a piecemeal manner.

I had 'torn' out my own background knowledge when writing the autobiographical account in Chapter 1 in order to give readers and listeners personal details that would enable them to make judgements about claims I made and ways in which I obtained data. I was determined not to have unrealistic expectations concerning gaining holistic insights into participants' backgrounds or overestimate their abilities to communicate details about themselves even if they had the inclination to share information with me. I did not anticipate intentional deception, because the advisers for VI had assured me that I would be welcomed into Schools 3 and 4 and arrangements were in place for September. I intended to put into practice another learning point from the pilot to ask participants to check stories I was proposing to tell about them, including recounting their interpretations of incidents, feelings at the time and if these had changed after they had time to reflect on what was said or happened. Chances for checking communication about an event or conversation had only been possible in a few instances in the pilot.

## **Taking a critical stance and examining postmodernism**

I questioned my own interpretations when analysing incidents noted in the pilot with the purpose of deciding why I viewed an incident as critical and how this might affect future development of the study. I wanted to keep lines of communication in frequent use with all participants during and after incidents and encourage and enable them to question their own and others opinions and ideas. The issue had become how to question and take a critical stance without confrontation that could destroy any hopes of forming constructive, communicative and collaborative working relationships in the future. The purpose of communication was not solely for providing information that purported to give accurate accounts of individuals' versions of usefulness of audio materials and ideas for future developments.

To clarify my thoughts I started to think of the methodological aspect of the whole study in terms of metaphors, likening its unexpected ups and downs to a roller coaster ride and collaboration to the parliamentary expression of "crossing the floor of the House". This interest led to attending a conference convened to explore use of metaphors for understanding. This was my initiation into the realms of postmodernism that suggested alternative and controversial ways of thinking and confronting issues that I had not previously considered. Talking to experienced and dedicated practitioners in this field of research provoked and extended my thinking about different methodologies.

The difficulty in defining a postmodern approach to research is acknowledged by Scott and Usher (1999, p.154):

In some ways it is easier to say what it is not - it is not another paradigm or another methodology, let alone a new tool-kit for doing research. All that can be safely said about it is that it offers a way of

resisting closure and possibilities for 'opening up' the research process, allowing us to ask the question - what is going on when we do research?

I was disconcerted by the deconstructive approach of postmodernism that I found disrupted and unsettled my thinking, but critically questioning what was written and spoken stirred up thoughts that otherwise might have remained dormant. Strengths and weaknesses of a postmodern approach seem to be hotly contested. There are those who claim that chaos does exist and must be acknowledged, whilst others deny that there is any turmoil or need for concern about mathematical education.

Views expressed by Stronach and MacLure (1997, p.109) endorsed the idea that I was proposing of applying strategies from a variety of methodologies:

Hybrid research need not imply an 'anything-goes' abdication of *methodological responsibility*. Each game plays and - to some inevitable extent - fails to play according to its own rules of validity. But it is the quality of the failure that is of interest.

My thoughts turned to students feeling that they were failures because they were underachieving in mathematics. I was reassured to receive support from this more unconventional source but less sure about the suggestion given by Stronach and MacLure (1997, p.111) that "respondents might be encouraged to rebel" in order to put into practice "a revised notion of *negotiation*, or of *dialogue* between researcher and researched." I agreed with the idea of making "interactions less asymmetrical in terms of power relations" but I was not in favour of the means proposed for achieving these ends. The main respondents would be students. If I followed this advice adults might be persuaded to disassociate themselves from the audio process without giving it a fair trial. If this happened

students would be denied opportunity to try an innovation that might assist them.

To prepare for starting the main study in September I devoted most time to formulating questions designed to inform the next practical phase. The questions listed below originated from learning acquired from running a pilot study, reflecting on how I had collected data and analysing findings, combined with constant recourse to relevant sources of literature. The questions are listed as they arose with brief reference to key incidents (KI) that had a significant effect on the course of the pilot studies. I applied learning gained from these to planning and taking action in phase 2.

- How to obtain adequate appropriate resources? (KI: recorders and listening devices were unsuitable for individuals and environments; further research needed.)
- How to adopt and change roles in response to people and circumstances? (KI: no warning that a student teacher would take over Caroline's class or Linda's new teacher not interested in audio process; plan ahead but respond to people and events with flexibility.)
- How to make constructive contributions without being over-critical but avoid being a passive bystander? (KI: constant individual support resulted in students not given a chance to work independently; necessary to suggest changes not just accept established organisation.)
- How to facilitate collaborative working? (KI: I only experienced collaboration with adults who worked with Caroline in mathematics; extend communication beyond the field of mathematics and the classroom setting.)
- How to find ways of improving mathematical and general communication skills? (KI: students were worried about

saying or doing the wrong thing; converse informally on various topics and give opportunity to ask questions.)

- How to acquire and share the skill of responsive, non-judgemental, listening? (KI: it took nearly a term for participants to realise the importance of this type of listening; request occasional withdrawal sessions to develop these skills.)
- How to engender interest and enjoyment? (KI: Caroline enjoyed being allowed to choose; offer choice, implement participants ideas and encourage a multi-media approach.)
- How to help individuals use and understand mathematical language more easily? (KI: students did not know many of the terms, listed for their age, in the National Numeracy Handbook; provide a purpose for speaking mathematically and discuss alternatives e.g. making audio-recordings.)
- How to involve students in decision-making and avoid any one voice dominating or being most influential? (KI: Caroline and Linda were reticent about voicing their views to me; arrange for students to talk to adults in the school, whom they trust, as well as the researcher.)
- How to hand over an innovation to others in a school? (KI: stopping involvement in the study was too sudden for Linda; allow time to pass on information and skills and leave written records and contact details in schools.)

I reasoned that whether questions caused chaos or clarity in developing inquiring minds and willingness to communicate criticism about the audio process would depend not only on the content of questions I asked but also on the way in which I presented these. I was hoping that students in Schools 3 and 4 would be allowed the freedom to define and express their own views and perspectives about situations.

Another characteristic of postmodernism I planned to incorporate into my research was how to judge difference. I was more interested in looking for methods and strategies that would complement further data collection than comparing and contrasting approaches reputed to conflict with each other. Dey (1993, pp.266-267) stresses, "the interdependence and mutual enhancement of apparently opposing approaches" He argues that "accounts can incorporate both narrative and analytic elements. It makes little sense, in my view, to emphasize one approach at the expense of the other." Nevertheless I found myself embroiled in debates about the pros and cons of objectivity and subjectivity when I was exploring methodologies that offered approaches somewhere along the continuum between these two extreme poles. I had decided to abandon searching for one methodological approach that would guarantee accurate observation and construction of rich pictures to give true representations of reality. Lakoff and Johnson (1980, pp.192-193) suggest "an alternative which denies that subjectivity and objectivity are our only choices." They focus on metaphor as "one our most important tools for trying to comprehend partially what cannot be comprehended totally" and claim that "what the myths of objectivism and subjectivism both miss is the way we *understand* the world through our interactions with it". I found attempting to find one relevant metaphor underlying the thinking of my doctoral thesis was a stimulating exercise before I attended the conference on using this method to assist understanding. I planned to apply this way of thinking in phase 3 for planning, reviewing and writing accounts.

I wanted to prevent frustration being caused, again, by missing information or misinformation in stories that I wrote due to being unable to contact participants soon after sessions. I reasoned that it was better to question myself and prepare questions for participants before I returned to being immersed

in fieldwork when I should have less time to turn to theory. If I could predict possible problems concerning communication I believed that I should be in a better position to obtain and understand reports from participants. I would have to wait until I was in the schools to find out which ways of obtaining, interpreting and judging participants' verbal contributions would be appropriate.

Habermas (1984, p.119) describes a problem that arises in the complicated process of interaction between people, "as soon as we ascribe to the actors *the same* judgmental competence that we claim for ourselves as interpreters of their utterances, we relinquish an immunity that was until then methodologically guaranteed". I had resolved to relinquish the complete control that I sought to retain in the pilot. Due to participants preconceptions of my role I had not been permitted to develop the type of working relationships I desired. This had given me unwanted immunity from comments and criticism from participants. In the main study I looked forward to being regarded as a researcher requiring assistance. I felt sure that I could accommodate to the same conditions as the students were working in because of my previous support work in classrooms. If I had known how attitudes towards me would differ because I was an outsider coming into unfamiliar environments with new ideas and wanting inside information, I would not have been so confident. Outcomes in the pilot had depended on opinions of people in influential positions, for example headteachers and senior post holders. I could not address the issue of power or anticipate how its deployment might influence matters until after the school holidays. I planned to use findings from one session to prepare for the next. I had felt frustrated, disillusioned and dis-empowered when adults withheld knowledge in the pilot, whether this was intentional or unintentional. It remained to be seen if I could prevent this recurring in phase 2.



## Lessons learned from the pilot study

I had used this break from fieldwork, when schools were closed during the summer holidays, to find out how experiences in the pilot study of obtaining data and analysing findings compared with other educational researchers and practitioners. I looked at strengths and weaknesses in methodologies that I had identified, thinking in terms of the focus of the research, roles, experiences and outcomes of similar ventures. The purpose of this operation was to enable me to make informed judgements about which principles to apply in the main research. I had learned from undertaking the pilot study how complex situations could be, even in familiar settings.

I reasoned that if I continued to critically review how I collected and analysed data I should be in a stronger position to argue a case to continue or change strategies that I was using. Objective techniques could still be useful for the technological aspect of the study but I would employ other methods to make subjective judgements on feedback from participants and social interaction. I would continue to question, analytically, if ways of observing, interviewing and recording data had been appropriate for the people involved at the time and in the contexts where incidents occurred.

I had already discovered that, to obtain an overall picture of situations, I could not ignore unexpected events or the fact that people hold certain sets of beliefs and follow individual ways of thinking not prescribed by any one particular methodology. Scott and Usher (1999, p.23) concede that, "there is a great deal of disagreement as to what actually constitutes a critical approach." They go on to advise that, "the relation of method to aims needs to be interrogated critically itself, or else one can get caught in the same ideological quagmire one means to escape". Choice of method that I made would depend on whether it seemed to be the most appropriate means for the

immediate and long-term purpose of the research. I did not have a hidden agenda as many people apparently suspected. I was not observing in classrooms to criticise pedagogy or talking to people to collect anecdotal data in order to present oral or written negative reports for outside agencies or research organisations. The focus of the study would remain firmly on facilitating inclusiveness for students in mathematics education in mainstream schools.

My main concern was how to apply, in the next practical phase, the insight and understanding that I had gained from running a pilot study. The following lessons seemed most significant:

- Extend research on audio items and obtain funding;
- Negotiate entry to schools with senior members of staff and other adults who would be involved;
- Question existing provision that seems unsuitable and suggest alternative or supplementary resources;
- Request occasional one-to-one sessions with adults and students for induction and skill training;
- Encourage adults and students to write scripts and make recordings as well as listening to them;
- Give verbal/written reports on progress;
- provide guidelines to use the full potential of the audio process;
- Develop communication skills for debating, decision-making and sharing knowledge and experiences;
- Apply methods found to be appropriate for constructing frameworks within which to work, purposefully, to collect and analyse data i.e. SSM principles; recording and reflective writing about critical incidents; case study approach by recording students' stories;

hermeneutic/interpretative approach to obtain and interpret feedback from participants. I knew from my own and others experience how crucial the start of any new venture can be. A tentative, open-ended, approach appealed to me and would leave the way open to make more methodological changes, if necessary, as the study progressed. I intended to keep the methodological aspect of the study under constant review.

Root Definition 2 was constructed to supplement Root Definition 1 (see p.59) and guide research in practical Phase 2: A researcher-owned system, that given the constraints of the NNS and school policies, offers students with little or no sight and adults working with them opportunity to *enhance and extend their experiences* in mathematical education, through *knowing the purpose of the research and the researcher's role* and *forming collaborative working relationships* to *establish and develop use of audio materials* within mainstream classrooms.

## **Methodology metamorphosis Part 2**

### **Phase 2 Theory and practice: Schools 3 and 4 (September-December 1998)**

This second part of Chapter 2 is concerned with the main research study but I intended to apply methodological lessons learnt from the pilot study and attempt to avoid making similar mistakes. One obvious error had been lack of negotiation with adults in schools before attempting to introduce the audio process into classrooms.

I intended from the outset of the main study to analyse incidents as soon as possible after they occurred and keep in mind "questions about the practical role of theory" (Carr 1995, p.113), that is, how theory could continue to inform ways of applying methodological approaches as well as how practice

might make a contribution to existing theory. I would be intertwining theory and practice by applying approaches discussed in the previous section with some of the ways already tried in the pilot. I would be identifying key incidents and examining analysis to find out why these had occurred and decide how to respond. The questions planned in Recess 1 would form a guiding framework at the start. My aspirations were that this approach would lead to understanding and gaining insight into how people, including myself, reacted and responded to each other and situations as we participated in the study. The quality of collaborative work would be affected by how, with whom, and under what conditions research methods were applied. I anticipated that communication leading to understanding mathematics and each other would be crucial if collaboration was to be productive and worthwhile.

The realisation that that there are no simple solutions to solving problems that arise in complex social situations was a motivating factor to go on looking for supplementary methods. Part of the preparation for the main research had been to select two students as case studies. I asked other advisers, employed by LEAs in London, to suggest children who were officially registered as being visually impaired, were encountering difficulties in mathematics and might find audio-recorded material helpful.

As explained in Part 1, Mohammed was one of the students selected to take part in the study. He was entering school 3 (960 students) for secondary education. Thomas, the other student chosen, was nearing the end of his primary education, in School 4 (230 students). Although Thomas was succeeding in most subjects, his school reports indicated that he was distressed by difficulties he was encountering in mathematics. I was not given a chance to talk directly with senior staff in either of the schools. The VI advisers for both LEAs insisted

that they should undertake negotiations with the schools and I was asked to communicate through them with members of management in schools when the term started. My plans to undertake careful entry preparations were thwarted. There was general agreement that it would benefit both students if I waited until the audio process was established with Mohammed before beginning to work with Thomas.

### *Mohammed*

Mohammed had talked easily and enthusiastically when I met him in his primary school. He was anxious to be treated like his peers and not be regarded as different because of his sight problem. He was articulate and clearly expressed his views. I was surprised that English was his additional language and barely spoken at home. His mobility was good, giving a misleading impression that his sight impairment was not serious. He was registered as partially sighted.

Mohammed maintained his enthusiasm to learn mathematics for the first few weeks in the comprehensive school. He was placed in a mixed ability class of thirty Year 7 students. His teacher, Ms Q, and his individual support teacher (IST), Ms F, suggested that audio-recordings might help other students as well as Mohammed. Unfortunately a series of events disrupted what seemed to be a promising start. I did not voice any criticism about organisation or what was happening inside or outside the classroom because I had planned to observe and work under the same conditions as Mohammed, in order to understand his thoughts and feelings in this new setting.

Ethical issues arose that I had not foreseen. After a few weeks, I was obliged to withdraw Mohammed from lessons and he wanted to talk to me about his general difficulties in the school whilst we were working on mathematical topics. He was worried about verbal bullying he was experiencing from his

peers. He asked to come to the special educational needs (SEN) room during lunch times. As stated in the Ethical Guidelines (BERA 2003, p.5), I agreed that the "the best interests of the child must be the primary consideration" but I was faced with a dilemma of how to respect confidentiality and ensure that adults in the school were aware of crises that could arise if preventative action was not taken. The type of communication that was possible and Mohammed's involvement in the audio process varied according to where it took place and the people who took part.

### *Thomas*

Thomas was placed in a mixed ability class of thirty students. He was congenitally blind and had no residual vision. He talked enthusiastically about his interests outside school but was reluctant to discuss mathematics until we got to know each other. His teacher, Ms X, was also the school's mathematics co-ordinator. She would be leaving the school at the end of the term. Ms Y was Thomas' IST and his SA was Ms U. One of Thomas' supporters sat next to him in mathematics lessons. I observed physical symptoms of stress on many occasions, especially when he was asked to write down answers. Communication with management was short and superficial.

The headteacher adhered rigidly to the decision that I should communicate with her and other members of staff through the VI adviser. This presented an impenetrable barrier to open, frequent interchange of information and ideas with key members of staff in the school except with the support staff. The earlier than expected departure of Ms X threw arrangements for continuing the research study, in the classroom, into disarray. I was asked to stop going into lessons because temporary teachers would be covering timetabled periods. There seemed to be a mismatch between views being expressed about Thomas learning mathematics and what I observed happening in practice.

The ethical aspect of trying to get to know varying opinions but not disclosing sources required careful handling. I was committed to respecting confidentiality but views about the whole situation were essential to gain an overview of the different perceptions held and claims being made about the value of Thomas learning mathematics in an inclusive setting and prospects for him when he transferred to secondary school.

I did not restrict communication to consulting people in the schools. I kept in contact with parents and Thomas' childminder who looked after him everyday for a few hours after school. I audio recorded, with permission, opinions of people prepared to discuss the evident difficulties that Thomas was encountering learning mathematics. The situation by December 1998 was that, in theory, schools 3 and 4 were continuing to support use of audio materials but in practice, for seemingly legitimate reasons, students were only allowed to participate in the process out of classrooms.

The Millennium Commission had agreed to provide funding for an extracurricular project that would mean I could offer use of audio-recorded materials to more students. The VI adviser for Mohammed's school supported the idea but due to illness, she was on long-term sick leave. In Mohammed's school all efforts were being directed towards preparing for an Ofsted inspection. People were preoccupied with other matters. Schools 3 and 4 did not offer supportive settings for research that focused on inclusiveness or a venue for a funded project that I planned to use as a way of extending the study.

I was despondent and depressed about the unexpectedly brief period I was able to spend in two schools undertaking case studies that I had anticipated I would follow through until the study ended. During the following months I realised the invaluable learning that resulted from reflecting on these unexpected setbacks early in the main study. I had to rethink

how to continue the methodological journey maintaining the focus of the research to which I was still strongly committed. I contacted another school but would have to wait until the following term to find out if this would provide a suitable environment for the research and the project.

## **Recess 2 (December 1998)**

In preparation for introducing the investigation into school 5 I could refer to findings from analysis of data that I collected in the first four schools. As I re-read notes and narratives and listened again to audiotapes I looked for links between findings to further inform my own learning and guide future plans. It seemed that because I had not made my concerns explicit about the difficult conditions under which Mohammed and Thomas were studying mathematics the outcome had been exclusion from classrooms, for both of them and myself. I had only been able to collect a minimal amount of data within inclusive settings. I had been given ample opportunity to get to know Mohammed's and Thomas' background, mathematical abilities and views and work with support staff out of classrooms but only occasional opportunities to respond to what was happening within classrooms. Given the situations that I encountered in schools 3 and 4. I could not consider undertaking long-term case studies in either of these environments. The driving force to continue the research stemmed from the empirical work from the pilot study combined with the realisation that my existing theory about the potential for enhancing access to the mathematics curriculum and learning was being transformed through trying out ideas in practice and learning from them.

Although I had consulted both students and the adults working with them and carefully worded introductory talks, some lines of communication had been virtually closed before I entered the



schools, due to insistence that I negotiated with management through a third party. Mohammed's distressing social experiences with his peers and the complexity of undertaking research in a secondary school in contrast to working in primary schools influenced my decision to introduce the audio process to students in year 8 working towards Key Stage 3 national tests. Before the term ended I had made an appointment to visit school 5, which was close to my home, on January 8<sup>th</sup> 1998. The purpose was to discuss arrangements to start undertaking research in this comprehensive school. The headteacher requested that I ran a short pilot study, with one student, to enable an informed decision to be made about whether introduction of audio materials into classrooms and launching a funded project would be a feasible proposition for the school. There was no VI adviser for this London borough, therefore the problem of a third party negotiating entry did not arise. I had time in this recess to review, in depth, methodological approaches already tried and thoughts motivated by experience-based practice over the past three months, but from recent experience I knew my plans for phase 3 had to be flexible.

### *Methodological learning from re-analysis*

From ongoing analysis over the past term, incidents involving ethical and environmental issues appeared to have required most attention when making plans for subsequent sessions. Searching for reasons why these had adversely affected the course of the investigation revealed how poor communication could exacerbate problems and threatened to jeopardise the future of the whole study. I encountered difficulty respecting confidentiality and maintaining open, honest communication with all participants.

I was aware that individuals did not want or expect their confidences to be communicated to others, but their views were important. The major dilemma was created by a discrepancy

between the desires of both Mohammed and Thomas to continue to use the audio process and adults in schools not listening to their views. I could only ascertain that this was due to their apprehension about more demands on their time and energy already stretched to the limits. No one in either of the schools offered a reason along these lines.

My decision to allow plenty of time to get to know participants and accommodate to the same conditions as the students seemed to have been misconstrued. I had relinquished the idea of keeping control to the extent that my role and consequently the research had been marginalized by people in influential positions in both schools and regarded as incidental and unimportant. Except for support staff no adults appeared interested in getting to know more about the origins or thinking that underpinned the research. Teachers in both schools were evidently relieved that due to an unexpected series of changes in circumstances they could justify reasons why I should be required to withdraw a student with VI from lessons rather than undertake my study in the classroom. This way of working gave me responsibility for the student and contribution from members of staff was minimal. I was forced to focus on a search for positive aspects of exclusion (See Chapter 4) instead of investigating responses in an inclusive setting as intended.

One methodological aspect that in-depth talk with individual students enabled me to develop was how to obtain information without maintaining constant control of conversations or continually interrupting to keep talk on track. Listening again to audio recordings made me realise that I was not allowing pauses for respondents to collect their thoughts before they spoke or reconsider what they has said after making a comment. I had begun to consciously develop the art of adapting communication to situations and topics under discussion instead

of interrogating contributors. I intended to consider people and settings at all times and make explicit in reports and accounts where the information exchange had taken place. In the accounts I kept in my logs I acknowledged my own shortcomings in situations.

I had underestimated difficulties that could be caused by the necessity to adapt to communicating with people of different ages and status and to unexpected environmental conditions. Delamont (1992, p.109) stresses that researchers must make explicit the context in which conversations take place, there is a clear distinction between recording "data deliberately elicited" and other instances when "dealing with talk gathered "in passing".

### *Reviewing and planning future applications of SSM*

The wording of root definition 1 had depended on my worldview before I embarked on the main study. I had inevitably lacked insight into possibilities and constraints that may lie ahead. I was, now, in a more informed position to answer the question "does the suggested root definition seem to have a chance of being useful?" (Checkland 1999, p.167). I believed that I could predict with greater certainty conditions that might militate against introduction of audio materials into mainstream classrooms. Checkland suggests that "it is often useful to include a number of constraints in the definition ... their effect can always be tested subsequently by relaxing them and seeing how the model of the system then has to change (ibid, p.168). I had found it necessary not only to make additions to the original models but also to create others. Checkland acknowledges that, "the step from the root definition to conceptual model is the most rigorous in the whole methodology" (ibid, p.170) and comments that it is clear:

that at stage 5 it is difficult to avoid seeing the root definition as normative if there is only one root definition and one model. The way to avoid this is to entertain several root definitions, best of all including incompatible ones, and to make models based on more than one of them.

(Checkland 1999, p.208)

I intended to draw attention to views voiced by participants as these would influence construction of conceptual models and methodological plans. Significant changes in the wording of these are written in italics. The emphasis on students taking a more prominent, active role in the audio process would be a significant step forward at this point. The funded project would provide a means as it included a proviso that it must be run out of school hours. Two examples of root definitions that I hoped would prove useful during my first term in school 5 were:

*Root definition 3a: A researcher-owned system that, given the constraints of the NNS and schools policies, encourages and enables students to choose whether or not they wish to continue using audio materials in lessons and take part in founding a lunchtime audio mathematics club that offers opportunity to reinforce and revise topics already learnt.*

*Root definition 3b: A researcher-owned system that, given the constraints of the NNS, schools policies and ethicality, provides opportunity for those playing an active part in the audio process to voice their views and participate in decision-making for introducing audio items, explaining roles of participants and administering the club leading to formation of collaborative working relationships to put ideas into practice.*

Using Social Systems analysis I would continue to question roles, norms and values. From my first experiences of being an

outside researcher in a school, I had discovered that how to introduce myself and the purpose of the research could affect how participants perceived my role and their expectations of the role that I would play when I was in classrooms and consequently the type of working relationships possible. At this stage I could only theorise about their possible expectations and values.

In School 5 one of my prime tasks would be to get to know how people with sufficient power to influence the course of the research related with others members of staff and the policies in place and being practiced throughout the school. I could not ignore or discount this aspect of the study as I had tried to do in the previous four schools. I intended to give priority to getting to know people and policies in the department of mathematics. I would not restrict this knowledge to classrooms in which the selected students were working.

### *Reviewing an hermeneutic/Interpretative approach*

Findings from analysing sessions spent with Mohammed and Thomas indicated the significance of the elements understanding, interpretation and application and the role of language in my study. Gadamer (1975 p.274) discusses these three elements:

understanding is always an interpretation, and hence interpretation is the explicit form of understanding. In accordance with this insight, interpretative language and concepts are also an inner structural element of understanding. This moves the whole problem of language from its peripheral and incidental position into the centre of philosophy.

Details of the central role of language in the audio process are given in Chapter 3. Without good communication in language comprehensible to all of us engaging in dialogues, it would be impossible to obtain opinions and

ideas which would form the foundation on which to build the study. Understanding and interpretation were both vital elements but these, alone, were not sufficient. As Gadamer (1975, p.275) states, the third element, "application" has "to be as integral a part of the hermeneutical act as are understanding and interpretation." The missing component in Schools 3 and 4 had been application. There had been no deliberate action to bring about the desired change and improvement. I had concentrated on working within existing conditions thinking that there was no time pressure to obtain background information. Adults in schools apparently interpreted my approach as acceptance of what was or was not happening in classrooms. In my efforts to be unobtrusive and adapt to circumstances the whole research process was being dismissed as unimportant. People in positions of power did not complain because I was making few demands on them and was not questioning aspects of mathematical education in the schools. This was a critical moment in the metamorphosis of the methodology of this research.

In these schools, the maximum number of differing opinions that I had been able to obtain about any one technical or general issue was five including my own. This limit resulted from the requirement for me to withdraw students from lessons and the reluctance of adults to become involved. I was presented with an unexpected opportunity to pilot in-depth, on a small scale, how to record, check and compare different views and use these as contributions to decision-making. Critical incidents that created a turning point in the research occurred during debates about whether I should continue or stop visiting these schools. It was not possible to come to a consensus. I discuss the problems of reaching agreements later in this section.

It was during a supervision meeting that thoughts were put into words that I had been unconsciously using an action research approach. During fieldwork I had been applying SSM methodological strategies for collecting and reflectively analysing data then using findings to plan for subsequent sessions. I had been focusing on the link between understanding and interpretation mainly in mathematical language but application in an inclusive setting had been denied. I had been following cyclic patterns that I had naturally employed as a practitioner when teaching or visiting schools in an advisory capacity. When I read the "Action Planner" (Carr and Kemmis (1986, p.7) during a visit to Australia I realised that I had been thinking, unconsciously, in terms of "the four moments" of action research as I planned and reviewed sessions that I had spent with students and those working with them during the past six months:

- to develop a *plan* of action to improve what is already happening;
- to *act* to implement the plan;
- to *observe* the effects of action in the context in which it occurs;
- to *reflect* on these effects as a basis for further planning, subsequent action and so on, through succession of cycles.

I had taken it for granted that implementation would be straightforward, so that the focus of the inquiry would be upon the effects of action as experienced by students and adults. In the next fieldwork phase I would consciously apply 'more systematically and more rigorously', an action research approach and think in terms of moving "in a spiral (forwards, or upwards)" (Winter 1998, p.65). In this recess I based my plans on accounts written by experienced action researchers. In

the following section I discuss my understanding of the principles of action research and how I intended to put these into practice during the remaining opportunities for fieldwork, as yet unknown.

### *Action-research*

I use the hyphenated version of action research (Winter 1989, p.149) to indicate my belief that action (practice) and research (theory) are inextricably linked. In his extensive discussion about the "mutual relationship between the two" Winter (1987 p.23) refers to:

the theoretical necessity of a reflexive conception of research's relation to action, so that their relationship may be theorized in ways which preserve the authenticity of both, i.e. which preserve research's capacity for achieving a critical distance from action AND preserve action's intelligibility as a creative rather than a causally determined response to interpretive meaning.

I interpret the term critical in relation to methodology, as meaning that the differences and interdependence between practice and theory must be understood, applied and linked in order that the findings from research can be translated back into the world of action. I was discovering that moving from one phase of practice to the next was not a linear, causally-determined response to previous episodes of dialogue or action, but rather a generative response that often led to re-thinking strategies.

Noffke, a practitioner of action research in schools for ten years, and currently an Associate Professor in the USA, writes about "some areas in which historical and conceptual work in action research has been done" (Noffke 2002, p.13) in a variety of countries, including the UK. Her overview dates back to the



1930s when Lewin and his associates became interested in minority groups and "focused on understanding and changing human action, often around issues of reducing prejudice and increasing democratic behaviors" (ibid, p.14). I had concentrated until this point on the minority group of students with VI but I still cherished the idea that members of other minority groups may become beneficiaries of the audio process for accessing mathematics.

McNiff (1988, p.3) writes that "the social basis of action research is involvement; the educational basis is improvement". I had fulfilled the requirement for involvement and from this point onwards I intended to pursue the aim to bring about improvement. McNiff is critical of action research schemes that "have become prescriptive rather than descriptive" (ibid, p.33) because researchers have interpreted the methodology of this approach too rigidly. It would be important to avoid imposing constraints on this research study by applying principles inflexibly.

Elliott (1997, pp.25-26) concludes that "action research cannot be paradigmatically distinguished from other forms of research in term of gathering methods" but he suggests that:

what distinguishes action research from other forms of educational enquiry are its transformative intentions and the methodological principles (not methods) such intentions imply. The methodology of action research might be briefly summarized as follows:

- it is directed towards the realization of an educational ideal, e.g., as represented by a pedagogical aim;
- it focuses on changing practice to make it more consistent with the ideal;

- it gathers evidence of the extent to which practice is consistent/inconsistent with the ideal and seeks explanations for inconsistencies by gathering evidence about the operation of contextual factors;
- it problematizes some of the tacit theories which underpin and shape practice, i.e. taken-for-granted beliefs and norms;
- it involves practitioners in generating and testing action-hypotheses about how to effect worthwhile educational change.

My pedagogical aim had not been possible in practice; it remained a theoretical aim. The challenge would be finding out the effects of applying action-hypotheses in practice by taking an active role to improve situations not just hoping it would happen. I intended applying the six principles proposed by Winter (1989) and outlined below as a framework, to complement strategies that I had tried since April 1998.

### *Principle One : Reflexive Critique*

Reflecting on events and dialogue as soon as possible after fieldwork became an important feature of my methodological approach. I depended on ongoing analysis of data to plan questions to guide action in subsequent sessions. Reading narrative accounts that I wrote later, after further reflection, was an informative enlightening experience and indicated the value of this method for recalling interpretations of reality at different stages of the research and in different contexts.

Winter (1989, p.39) poses a question of particular importance: "how can we analyze the process of making judgements, without simply imposing a further set of judgements? It is here that the principle of reflexivity is relevant." He goes on to explain what a reflexive judgement entails:

a reflexive judgement is inevitably bent back into the speaker's subjective systems of meanings ... since there is no way of grasping what it is that we perceive except (partly at least) through language itself, language structures our consciousness and at the same time, our relationships with others.

(Winter 1989, pp.40-41)

Communicating in mathematical as well as in colloquial language was an integral part of the research. In phase 3 of the study, I planned to follow a reflexive critique path as described by Winter. I would continue to make explicit ways in which I collected data and question why information might have been omitted but would avoid being prescriptive. As Day (1999, p.218) suggests I would record reflections relating to issues of "emotional intra- and interpersonal and professional dimensions of teaching which are key drivers of teacher care, commitment and quality." Although I was officially a researcher, teaching was an essential activity in use and production of audio-recorded materials.

I had found it problematic trying to reflect-in-action whilst carrying out research in classes of thirty students. I was reassured by Winter's (1989, p.42) own learning from experience, "in practical life reflexivity must go unnoticed, so that the complex skills of communication can be managed". Reflecting on my role in situations I realised that like many teachers and now as a researcher I was applying experience and skills intuitively. Hart (1995, p.214) suggests that experienced teachers "need to become aware of the possibilities for further developing the sophisticated interpretive resources, which they have already acquired through teaching." I was beginning to recognise how my personal resources, acquired from past experience, could be influencing my reactions. I wanted to develop these resources and be able to

talk and write about them in a comprehensible form that would be helpful to listeners and readers. Atkinson and Claxton (2000, p.3) and other authors who wrote chapters for their book believe that, "intuitive forms of knowledge and ways of knowing have tended to be ignored and under theorised". They stress that it essential to "uncover the ways in which explicit knowledge and implicit 'know-how', reason and intuition are braided together" (ibid, p.8). I resolved to take a pro-active role in situations and make my thinking and reasons for action explicit.

### *Principle Two: Dialectical Critique*

I wanted to portray the whole picture of reality as participants perceived it and obtain background information to explain why and how our interpretations and perceptions varied. I was still focusing on investigating the audio process as a means of facilitating inclusiveness for students. If I ignored any individual or event I would skew the picture of the real world of mathematical education that participants were experiencing within schools.

Winter (1989, p.46) describes Dialectics as:

a general theory of the nature of reality and of the process of understanding reality, yet its original Greek meaning is 'the art of discussion' (or more literally: 'through or by means of words')... we can experience reality only by means of our competent participation in the complex structures of language.

The course of this study would continue to depend on the competency of participants, including myself, to communicate and interpret words when voicing our perceptions of reality and our commitment to take action in response to ideas other than our own:

individuals are products of their social world, we can also say that the social world is created by individuals' action. We can make both statements simultaneously because 'action' is not 'behaviour' (the effect of a cause) but 'praxis' (the creative implementation of a purpose) ... dialectics gives us a principled basis for making selections.

(Winter 1989, p.51)

I had evidently not conveyed to adults or they had not understood the crucial component of choice that was implicit in the thinking that underpinned the study. I was offering opportunity for participants to choose audio items within the limits of what I could provide, voice their views about audio production and ultimately choose if they wanted to carry on using an audio process. So far none of the students had been offered a chance to make selections about where and when they wanted to use audio materials in their schools.

When analysing interpretations and ideas I would be looking for commonality and contradictions. I would not restrict the aim to improving production of audio materials for individuals. I needed to make clearer my message from the start that the audio process was intended to help include students in mathematics education. I would not be limiting the sphere of the study to classrooms. I assumed that I was now better prepared to adapt to unexpected events, than when I started the research. I felt that I was beginning to understand Schön's (1991, p.354) comment that:

one must make some new sense of the situation in order to incorporate the surprising event, the backtalk, or the multiple plausible stories one has discovered. And one must then test the new sense by an on-the-spot experiment.

Schön (1991 p.353) goes on to explain that a productive way of proceeding is to exploit a surprising event and derive from it a way of designing of "a new intervention". I was interested in finding new ways of undertaking activities and applying methods that I had already found problematic and might enable greater insight into reality, as it was in schools in 1999. Immediate ideas were to include reflection-in-action, analysing mismatch between participants' interpretations of events and dialogue and attempting to explain how environmental influences and the relationships between them were affecting opportunities for inclusiveness.

### *Principle Three: Collaborative Resource*

Findings from analysis of data already collected indicated that collaborative action was necessary to implement new ideas in combination with clear, comprehensible communication with participants. I had found it difficult to understand why adults had been resistant to working collaboratively with me when our pedagogical aims on paper and in discussions seemed to be in harmony. I was left in no doubt when teachers did not want visitors, especially researchers, into their classrooms during mathematics lessons. This had been evident in the schools that Mohammed and Thomas attended. My interpretation of working collaboratively in this study is summed up in the definition given by Winter (1989, p.56):

collaboration here is intended to mean: everyone's point of view will be taken as a contribution to resources for understanding; no-one's point of view will be taken as the final understanding as to what all other points of view really mean.

Collaboration with both students and adults in schools was crucially important to this research. We were not attempting to find solutions that would suit all listeners and producers of

audio-recordings but rather accumulate a variety of ideas and methods, which would motivate others to undertake further investigation.

I had been surprised that members of staff suspected that I had an ulterior motive for undertaking research in their schools. I would be prepared for this reaction in phase 3 and keep in mind Winter's comment that the whole process depended on 'who' was involved in the action not on idealistic aims decided in advance: "action research, then, cannot be free of contradictions and ambiguities - indeed one of its central themes 'collaboration', is notoriously ambiguous:

'collaborators' may be friends or traitors - it all depends on who they are collaborating with! (Winter 2002b, p.40)

I wondered how different it would have been if I had been a member of a research team. On the one hand it might have helped to form more representative pictures of situations and individuals, if views of different observers in the same setting had pooled their views. On the other hand, there were evidently disadvantages as discussed by Scott (2000, p.17). Disagreements and contradictory interpretations within the team might have diverted attention away from the focus of the research and probably, as Scott observed in his research studies, "unintentional bias termed as 'honest error' or intentional 'dishonest error' would still have occurred" (Scott 2000, p.17). I was looking forward to being welcomed into School 5 and exploring in practice ways of working harmoniously with students and adults.

I would attempt to achieve the aim of valuing contradictory elements of a viewpoint, not dismissing anything as irrelevant and allowing accounts to challenge each other; "the analysis of a situation into its constituent contradictions is not a mysterious or a mechanical technique, but a way of ordering one's thoughts (Winter 1989, p.55).

I could not be sure how I would respond when resolving differences of opinion and interpretations in the next phase but I wanted to fulfil the requirement, that researchers should be able to "affirm without dogmatism and confront without hostility" (Hainer 1968, p.36 cited by Schön 1991, p.355). Moreover "the researcher needs not only to exhibit these sorts of competence but also to help his co-researchers acquire them" (Schön 1991, p.55). I was hoping to work with students and adults as co-researchers in school 5. One way of tackling this problem would be to work collaboratively with students and adults valuing all interpretations and contributions. Winter (1989, p.59) points out that another value of the collaborative process is that "it acts as a challenge (a check upon) one's subjectivity, (one's personal starting points and assumptions)". I was determined not to dwell on self-doubts about increasing inclusiveness in mathematics through use of the audio process. I intended to take a positive, constructive approach regardless of the recent unpredicted setbacks.

#### *Principle Four: Risk*

I had regained a strong sense of purpose having decided to take a pro-active role in opening opportunities and enabling participants to work collaboratively with each other and with me. Nevertheless I was apprehensive about introducing the audio process into a large comprehensive school. I would be entering into unknown territory and risking putting forward an innovative idea that although not intended to threaten or be critical of members of staff seemed to have had this effect in the first four schools. This time I would be going into a school with the realisation that I had to take risks. As Winter (1989, p.60) explains:

the principle is that initiators of research must put themselves 'at risk' through the process of investigation ... the process is not merely one of



exposure to refutation, but exploring possibilities for transformation ... what may be transformed (and thus in this sense 'at risk').

I felt that I had "a capacity for change" (ibid, p.61) and was willing to put my practice and viewpoint at risk. I was preparing as thoroughly as possible for the next period of fieldwork. I could only hope that participants in school 5, through understanding the aim of the study and methods I proposed using, would be willing to work with me and also take risks. I was determined to keep an open mind and respond positively to unexpected ideas and events during the next phase of fieldwork. Winter (2002b p.40) relates risk to the research process: "to claim 'integration' and 'coherence' is to risk losing dialectical pluralism and openness, and descending into prescriptive authority". I would try to ensure that any advice that I gave or suggestions I proposed were not communicated in a prescriptive, authoritative manner. From my work in the pilot study and with Mohammed and Thomas I had begun to realise how much I could learn from students as well as adults. I was not aiming to impose my ideas and aspirations on others. As Winter (1989, p.60) concludes the only hypotheses worth supporting "are those which have newly emerged in the course of our inquiry; those we started out with we will wish to transcend."

Noffke (2002) writes on the theme of collaboration in action research between people in schools and those in higher levels of educational institutions. She refers to the efforts of the Collaborative Action Research Network founded in the mid-1970s, "in much of these works, there is a clear emphasis on the role of action research in the development of a profession which is concerned with ethical issues as well as technical ones" (Noffke 2002, pp.18-19). I had only recorded participants' voices with their permission but there was an ethical dilemma. How could I use the insight I gained into situations by

listening to them talk, without divulging their identities or putting them at risk of being persecuted by others for collaborating with a researcher?

### *Principle Five: Plural structure*

I planned to apply the principles of reflexivity, dialectics, collaboration and risk when making decisions about which incidents were critical, in order to write an account that would "act as a *discussion* document through which the dialectic of theory and practice can move back from the moment of theory (the report) to the moment of practice (what is to be done with the report)" (Winter 1989, p.64). I would be trying to establish a form of communication with readers that would make them feel that they were sharing experiences of people who had been involved. I wanted to encourage them to question happenings and research methodology employed, so that they were prepared for similar situations that they may meet.

I decided that I could only claim to be able to write a narrative account of the study and case study stories that represented participants' understandings of dialogue and events by acknowledging that I was the "subjective presenter of a *plural* text which is frankly constituted as a still non-unified assemblage of disparate realities" (Winter 2002a, p.151). I was interested in how other writers facing similar problems tackled the issue of truth and authenticity. Judging validity of an account was expressed in a variety of ways. I decided to adopt a combination of their methods. Winter (2002a, pp.144-145) questions whether an account of a specific situation "gets sufficiently close to its underlying *structure* to enable others to see potential similarities with other situations" and asks if accounts claiming to represent the 'truth' are "not only 'corresponding to the facts', but also 'trustworthy' ... the 'value' of the work depends in part at least on how far others find the report 'persuasive'." Checkland (1999, p. 173)

discusses validity in terms of claims being "defensible or less defensible". He queries the efficiency of the methodology and uses as a criterion that "the best we can hope for is that in the eyes of concerned people former problems are now rated as 'solved' or the problem situations are rated as 'improved' (ibid, p.241).

Authenticity is a term open to subjective interpretation. How genuine can an account be if its content depends on meanings attributed to action and communication from an individual viewpoint? Winter (1998, p.53) addresses this issue, as does Walmsley (2001, p.203) whose proposal that we should make "it possible for people with learning difficulties to engage as equal partners" mirrored my own. Both authors strongly argue the case for taking action to enable the culturally silenced to find a voice.

Winter (2002a, p.151) suggests that, "the text is both incomplete and disunified, presenting a tentative set of possibilities rather than an achieved and final understanding." I proposed combining this idea with use of metaphors to overcome problems of inaccurate representation of reality.

the possibility that what something means to me may be based on *kinds* of experiences that I have had and you have not had and that, therefore, I will not be able to *fully* and *adequately* communicate that meaning to you. However, metaphor provides a way of *partially* communicating unshared experience, and it is the natural structure of our experience that makes this possible.

(Lakoff and Johnson 1980, p.225)

In January 1999 I would be trying to persuade people to take part in a study that I was convinced could be of value to students and adults who agreed to be involved. I had discovered that numerical data I thought that I should and could gather

and use to justify validity and reliability of this research was firstly problematic to collect and secondly inappropriate for communicating the purpose and findings of the research.

According to Winter (2002a p.148): "practical work is only one of a number of possible outcomes" and "analysis is only a tentative structuring of divergent perspectives - one that can be justified not as accurate, but merely as 'trustworthy'."

### *Principle Six: Theory, Practice, Transformation*

One positive aspect of working out of classrooms with Mohammed and Thomas had been the opportunity to obtain feedback from them as they were listening to and producing recordings. Based on their experiences and ideas I realised some of the advantages and disadvantages of the audio hardware and software. I wrote guidelines designed to assist adults and students to take over responsibility for some of the essential activities already identified, for example induction sessions. I would continue to request ideas for making changes to improve recordings. I did not assume that the present guidelines, methodology for collecting and analysing data or themes that had emerged would remain in their final form. There would always need to be additions or alternatives to existing provision. I had time to reflect on findings and oversights during the school holidays over Christmas. The interdependence between practice and theory was evident. Winter (1989, p.67) emphasizes that "mutual questioning between theory and practice is strictly unending." MacLure (2002, p.70) reinforces this point of view "postmodernism refuses to choose between theory and practice". I intended to leave the way open for development concerning not only the audio process but also the process of inclusiveness that I hoped would be more in evidence in school 5. Winter summarises this principle of action-research:

theory being based in practice, is itself transformed by the transformation of practice. It is this final argument, that theory and practice need each other and thus comprise mutually indispensable phases of a unified change process, which presents the strongest case for practitioner action-research.

(Winter 1989, pp.65-67)

My aspiration was to contribute to knowledge not merely to provide confirmation of existing theory. I reasoned that using a multi-method approach could offer a way of working, which would raise further theoretical questions and issues concerning appropriateness for application in practice. I anticipated that comparing and contrasting principles associated with the different approaches would provoke and expand thinking and lead to learning that would be an asset, in practice, for students and those working with them.

### *Different types of action-research and action researchers' roles*

One of the crucial changes that I was intending to make in school 5 was to make clear from the outset that I was seeking help from students, as co-researchers. I had spent this recess reconsidering my methodological approach in phases 1 and 2. I felt more informed, theoretically, about some of the general principles of action-research and was looking forward to trying these out in practice. Based on how I was proposing to proceed with the study, it seemed a natural progression to incorporate the theories and ideas integral to emancipatory and participatory action-research into my plans. Tesch (1990, p.66) writes that "like collaborative research, emancipatory action research is successful to the degree in which the knowledge produced results in improvement of practice".

Walmsley (2001, p.188) questions the "consequences for non-disabled researchers of acting as allies" in "research which

includes people with learning difficulties as active participants". Although the individuals with whom I would be working would not necessarily be categorised as having learning difficulties, I felt that the observations that Walmsley makes were relevant to my research. She raises issues concerning "inclusive" and emancipatory research that would be important in the next practical phase when I would be offering students opportunity to contribute to "control, rather than merely participate in, the research process" (ibid, p.195). I planned to put my "knowledge and skills at their disposal" (Barnes 1992, p.122 cited by Walmsley 2001, p.195) and ensure that I did not speak for them.

Cohen et al (2000, p. 230) make reference to the works of others including Torres (1992, p. 56) who sets out "several principles of participatory research" that include defining the role of a researcher "as facilitator, guide, formulator and summariser of knowledge and raiser of issues". On reflection I realised that I had already adopted each of these roles at different times in the first four schools. I wondered which additional roles I would be required to adopt in the fifth school. With more funds for audio items available I anticipated that a greater number of students would become involved.

There is considerable commonality in views expressed by protagonists of SSM and action-research approaches about the role of the initiator and coordinator of a research study and tactics to adopt to avoid their voices dominating in decision-making. Perhaps this is not surprising given the history and aims of both approaches. Checkland et al (1990, p.16) express hopes that the intellectual framework they propose "will yield insights concerning the perceived problem which will lead to practical help in the situations and that experiences of using the framework will enable it to be gradually improved." In his more recent publication Checkland (1999, p.223) warns that,

"the systems thinker must be able cheerfully to abandon his earlier choices of relevant system and start again. And again".

I would also need to be prepared for a difficulty identified by Winter (2002a, p.148) related to how to "register the need for a critique of immediate experience without appearing to adopt the stance of one who already possesses an enlightened/emancipated perspective, from which the perspective of others can be dismissed as ignorance, neurosis, false consciousness or delusion." The idea of reflexive thinking is implicit in the way all these views are expressed and there is no limit on the number of times it may be necessary to repeat and change ways of putting ideas into action. MacLure (2002, p.68) comments from a postmodern perspective that as researchers: "we even have our heroes and heroines - the evaluator as existential hero (arguably a masculine identity, even when assumed by women) the action researcher as knight, missionary or barefoot doctor." I would try to avoid focussing only on participants prepared to be actively involved and able to make positive contributions to the research and give equal, if not more, attention to those unwilling to take part and openly or covertly critical of the audio process. Cultural concerns including gender and minority groups would also be uppermost in my mind.

My feelings at the end of phase 2 had been disappointment verging on despair. I seriously considered abandoning this research study. Motivation to continue came from three sources. Firstly students' feedback was paramount in this study and they were in no doubt that the innovation was having positive benefits for them. The second source of support came from supervisors, family and friends who persuaded me that the venture was worthwhile pursuing. Finally, I recalled the many incidents that I had viewed as failures in past years, which had eventually led to invaluable learning, that I may never

have experienced without passing through a pain barrier of disillusionment and disenchantment with everyone and everything. I hoped that my recent experience that seemed like failure would with hindsight prove to be only another temporary setback. Time would tell! I wish that I could have read the following reassurance about the action-research process but it had not been published:

the essence of action research is that, although the inquiry may have an individual initiator with a specific *provisional* focus, this focus can change as soon as the inquiry is underway as other participants contribute crucial insights. Also action research follows a developing situation as it changes over time. For both these reasons the later phases of an action research inquiry will need to take into account theory which was not envisaged at the outset.

(Winter 2002b, p.36)

I was the 'individual initiator' and over time I was discovering the need to change certain aspects of the research but not the main focus. The target population and the type of environments into which I was introducing the audio process were in the midst of change. I had not conceived my study as action-research until January 1999. I intended to leave the way open to incorporating other forms of theory that I had not envisaged at the outset. I would be requesting active involvement by students and adults in implementing ideas to bring about improvement for accessing mathematics in print. In addition to collecting their opinions on positive and negative aspects of use of audio I would be asking for their suggestions concerning how action should be taken to put thoughts into practice.

MacLure (2002) emphasises the necessity to question methods and techniques of qualitative research such as observation,



interview and data analysis and to find hidden meanings and patterns. She offers advice worth following both from the point of view of awareness and taking action to avoid distortion of accounts claiming to present a true picture of how methodological approaches were applied and action implemented. I would guard against analysing data "to make it yield truths, trends or themes" that had previously been pre-determined or to using triangulation for checking accuracy and 'validity' of participants' versions of events or dialogue with the sole purpose "to provide a secure foundation" for my own thoughts and actions (MacLure 2002, p.68).

### *Critical action-research*

I was realising the value of questioning and being critical. I wanted to benefit from the experience of other researchers in order to direct my efforts to preventing methodological problems arising rather than resolving crises. For this reason I envisaged conducting the research in a "critical manner" (Winter 1987, p.23).

Kincheloe (1995, p.74) defines five requirements of critical action research that in his opinion "becomes the (logical) educational extension to postmodern critical social theory." I was not an insider teacher or researcher but these requirements seemed relevant to the type of study I was undertaking. I discuss each requirement in relation to my own philosophy, belief, values and practice concerning the investigation in progress:

"First it rejects Cartesian Newtonian notions of rationality, objectivity, and truth. Critical action research assumes that methods and issues are always political in character" (ibid, p.74). I had found it impossible to accommodate to how school micro-politics had affected whether students were permitted or denied use of audio materials in classrooms regardless of their

desires. Reasons given for denying opportunity seemed legitimate but I was not in schools long enough to find out truths that I suspected lay beneath words glibly spoken by people in positions of authority. I was not only interested in interpretations that could explain why the innovation was being rejected - I wanted it to be allowed to happen in practice. The implied message in four schools was that I was welcome to continue with my research out of classrooms but not in them.

"Second, critical action researchers are aware of their own value commitments, the value commitments of others and the values promoted by the dominant culture. In other words, one of the main concerns of critical action research involves the exposure of the relationship between personal values and practice" (ibid, p.74). I had found that I could not rely on verbally expressed intentions. People enthusiastically agreed with the principles of the audio process but in practice were not willing to change their way of working to enable this. Examples were headteachers whose support was entirely verbal, Caroline's parent who praised the process but gave no support at home even when I offered to help at anytime; and Thomas' GA who continued to sit next to him apparently determined to show that she was indispensable and he could not tackle tasks without her help. I considered the idea of asking for commitments in writing but decided that this would alienate people with whom I wanted to work and probably increase their reluctance to trust an outsider.

"Third, critical action researchers are aware of the social construction of professional consciousness" (ibid, p.74). Professionals' empathy with and knowledge about students, events and mathematics, depended on personal philosophies and their own past and present experiences in education. I was aware that the importance attached to an individual's views depended to a great extent on their social and academic status

within schools. In mathematics departments, the level of recognised qualifications that they held influenced members' status. As a doctoral researcher I seemed to be automatically held in high esteem, especially with the combination of degree level of learning in mathematics and over twenty years of teaching experience. Assumptions made about my ability and expectations had not always proved to be an advantage in the past. The headteacher in Thomas' school and the mathematics co-ordinator distanced themselves from the research from the start. The situation did not change and the GA, although supportive when talking to me took her lead from professionals in influential positions in the school. I could understand the external pressures on educationalists with frequent policy changes being imposed at the end of the 1990s but without practical as well as verbal support from people in positions of power prospects for any innovative research project seemed bleak.

"Fourth, critical action researchers attempt to uncover those aspects of the dominant social order which undermine our efforts to pursue emancipatory goals" (ibid, p.74). The extent to which I could apply means and students were permitted and enabled to take the opportunity to use audio materials had depended on historical and ideological factors. I had not possessed enough power to change matters. I thought that this would probably happen again in school 5. I felt privileged and grateful that schools had agreed to my request to undertake this research study with some of their students but frustrated by the thought that I would be powerless to influence any radical changes. In order to take preventative action I needed to get to know the history and present policies of the school in general and the mathematics department in particular. I would also try to uncover reasons for rejection of the audio process if this occurred again. I would keep schools informed about findings but my fear was that if I made critical comments

about educational matters opportunities to continue the study would be withdrawn. My regret had been that I was the only adult who asked Mohammed and Thomas if they wanted to carry on using audio materials. I had not managed to establish suitable working relationships between management and myself in any of the schools. I was anxious to avoid replication in School 5.

"And fifth, critical action research is always conceived in relation to practice—it exists to improve practice" (ibid, p.74). Knowing background information about writers, listening to them speak and meeting them face to face helped me to judge how closely I could align my own thinking with their definitions and applications of action research. Details I required concerning personal philosophies and ideologies were often difficult to find and not given in detail. I should like to have met more of these authors.

An issue that interested me was what individuals meant by seeking 'to improve practice'. Which principles were influencing their thinking and actions? How had they selected and changed techniques and strategies and applied these? I refer to words and phrases in particular definitions that made me think carefully and critically about 'improvement' and my own interpretation of this aim related to my research.

Carr and Kemmis (1986, p.192) define the role of the action researcher "to improve particular practices, understandings and situations by acting in a deliberate and considerate way in which understandings and values are consciously expressed in praxis." They define praxis as "action which is considered and consciously theorised ... and which may reflexively inform and transform the theory which informed it" (ibid, p.190). I intended to try to improve mathematical education for students with visual impairment in mainstream but I required more time in inclusive practice to know if contributions from this research would transform theories. Praxis meaning "informed

committed action" seemed an apt description of the type of approach that I would be taking. I was committed to introducing use of audio materials to students. I was planning to keep myself well informed through reference to theories that supported or contradicted findings. This recess gave me time to re-think and talk to others. My aspirations were that my learning might inform inclusive practice that other practitioners could turn to in their endeavours to undertake similar research studies.

I realised that introduction of the audio materials was going to be a gradual process that would take time. Elliott (1991, p.51) maintains that, "the fundamental aim of action research is to improve practice rather than produce knowledge". This seems to skew the balance between theory and practice. He writes that, "a felt need on the part of practitioners to initiate change, to innovate, is a necessary precondition of action research (ibid, p.53)". I retained this felt need despite problems encountered in five classrooms. I was thinking about methodological changes and additions that might lead improvement in ways of collecting, analysing and keeping records of data required. Observing and interviewing had emerged as main activities for gathering data and would be main concerns in phase 3. I was still experimenting with different forms of analysis.

### ***Observation and Communication***

The verb 'to observe' is generally associated with the action of 'seeing'. The other senses receive far less attention. Working with Caroline and Thomas made me aware of the necessity to combine watching with listening when trying to find out the nature of "reality". Touch and smell can also extend the powers of observation. I intended to take into consideration a multi-sensory approach. Methodological frameworks I proposed using would be guided by SSM and action-research principles outlined

in this chapter in conjunction with strategies from other approaches previously discussed for obtaining participants' views, interpreting and understanding these in order to improve communication and take action to make changes. I would use frameworks as a "developmental rather than merely repetitive" process (Winter 1987, p.43), using successive circles or spirals, flexibly, for planning and reviewing methodology and action taken. I would continue to undertake ongoing analysis and write narrative accounts after sessions, questioning my own thoughts and others to maintain a multi-perspective overview of the whole research process. I would be looking for chances to develop a creative approach rather than merely tackling a repetitive set of tasks. I decided to retain the term 'key incident' as defined in Part 1. I intended to try to improve matters for participants not merely adapt to conditions dictated by schools.

Somekh (1995, p.342) warns of the danger of interpreting models too literally as representing a set of very distinct steps, rather than broad stages in an integrated process ... the models are no more than graphical tools to help us to conceptualise the action research process and, used in this way, they are useful.

I intended to use knowledge and understanding gained from following a reflexive analytical approach to help decide and implement improvements in action within schools for gathering more data. Thinking along the lines of the importance of social relationships in learning, I began taking action by wording questions on audio recordings in terms of we and us rather than you and I to transmit the message to students that they were not passive recipients in relationships of 'I and thou', 'researcher and researched' or 'knower and known'. The whole process was a collaborative venture to which they were expected

to contribute and over which they would have a substantial degree of control.

Schön(1991, p.5) draws attention to the fact that "even when the author wants to help practitioners acquire a new set of skills or insights ... his or her primary concern is to discover what they already understand and know how to do". To make this discovery lines of communication would have to be established, kept open and used frequently with participants. Language would continue to be a central concern. I formulated questions that I hoped would assist good communication and guide applying a critical action-research approach in school 5, based on my interpretation of principles and issues discussed in this chapter and the focus of the study (see Appendix 3b).

### **Phase 3 Inclusive learning opportunity School 5, (January-March 1999)**

#### *Derek*

The headteacher of a school in South London (comprehensive 11-16, 1700 students) invited me to work for a trial period with Derek, who was in year 8, before deciding whether to agree to the audio process being introduced into classrooms and for the school to host a Millennium funded project. In School 5, I was allowed to explain the purpose of the research to the headteacher, without the requirement to communicate through an intermediary, as had been required in Schools 3 and 4. Derek's parents gave permission for him to be involved.

In a large comprehensive school checking participants' interpretations was more difficult than in compact primary schools where form teachers often also taught mathematics and students stayed in the same room. I went into the classroom for the first time as a general visitor with the aim of observing,

without any of the students including Derek associating me with research.

Derek was visually impaired and dyslexic according to his Statement of special educational needs. I wanted my first communication with him to be on equal terms with neither of us knowing the background or past history of the other. I had not looked at his school records or asked for other people's opinions before the initial induction session but nevertheless information was volunteered about his previous misdemeanours and difficulties in the school in Year 7.

I wanted to find out what Derek knew about me and the audio process, whose idea it was for him to try using this complementary medium for mathematics and what he thought he might gain from taking part. I asked him how he thought he could use his strengths and interest to assist in forming an audio mathematics lunchtime club and help with research. Derek spoke passionately about his work in art and his hopes for a future career in this field. Talk revolved around our thoughts for the future, interests, other curricular subjects and favourite leisure activities. I gave him opportunity to ask me questions about my work.

Without this one-to-one session, I might never have known about Derek's strengths and he would not have known about my work with children with sight impairment. He was intrigued by how students without vision could learn mathematics. He did not mention his sight problem until we were talking about a geometry mat and special film to enable Braille users to draw diagrams. Sight in one of his eyes had been impaired by an accident early in his life but it was evident that this was not affecting his near vision. He suddenly began to talk freely and openly about his own difficulties without any prompting. We drew on our own and each other's abilities and specialist fields in the following months.



Derek was in the lowest mathematics set taught as a whole class by Ms A, who was also his Head of Year. His withdrawal from one mathematics lesson a week for extra help with literacy was adding to his problems in understanding new mathematical topics. It seemed that he had decided that the only solution was to give up the struggle and pretend he did not care. He was surprised that I did not refer to his past reports or his disabilities during induction sessions, instead I was asking for his help with research. He asked questions that indicated genuine interest and desire to know more about piloting this and assisting with plans for the project. I followed up this session by discussing, with his teacher for dyslexia, additional difficulties that Derek was encountering in mathematics due to being withdrawn from one lesson a week for extra help in literacy. She was using Derek as a case study for the professional development course she was taking and did not support in classrooms for mathematics. The issue was eventually resolved with the help of the headteacher.

Derek was mathematically able but had difficulties reading and remembering, in the short term, text and numbers presented in print. The opening up of a world of mathematics for Derek was not a smooth, trouble-free operation but one he appreciated with hindsight. He was determined that he would not be deterred from being allowed to use audio materials in the classroom. He became the leading protagonist of use of audio materials and one of the founder members of the externally funded audio mathematics club.

I used the same strategies, that I had found helped me get to know students in the other four schools, to get to know Derek and conditions in classrooms in which he was placed. This time I was looking for opportunities to influence change to improve learning situations. With my recent experience, I was in a stronger position to make clear possible implications from the

outset. I continued to identify and analyse key incidents to open up opportunities for students.

I found myself in the predicament described by Dey (1993, p.52) "a problem with complex systems of ideas is that they often relate concepts which are poor conceptualisations of experiences. More attention is given to 'systemizing' ideas than conceptualizing experience." I was struggling to fit incidents into categories or create new ones. I had started using the NUDIST program as a supplementary analysis tool. I could understand the arguments for and against use of this computer program described by Vidovich (2003, p.90):

the positives usually emphasise the improved validity (interpretative and theoretical as well as generalisability) derived from greater visibility of the research process because there is an audit trail for others to follow and critique. The arguments against using computer software include distancing the researcher from data, over-fragmentation of the data and the strait-jacket effect of needing to generate 'neat' data to plug into the computer.

I finally decided that I would discontinue using this program and devote time to analysing feedback from contributors that reflected participants' views as accurately as possible for the purpose of taking constructive action to bring about changes necessary. I stopped trying to compartmentalise data into pre-determined categories.

### *Collaborative working*

I noticed the difference between working in a mathematics classroom in secondary schools where doors are firmly shut and another teacher in the room is regarded as an intruder, as opposed to lessons in primary schools where organisation is more informal and visitors are expected and welcomed. There are

always exceptions as was the case in Thomas's school and in the classroom where Linda was placed for Year 6.

After a month's trial, Derek was moved from the lowest to a middle band mathematics set. Derek and I decided together what I should tell the whole class about the audio process. In Mr D's classroom it seemed possible that a Collaborative Resource (Winter 1989) could be put into practice. I was committed to taking into account everyone's point of view but not searching for one opinion or suggestion that could be taken as the final understanding as to what all the other points of view really meant. I was convinced, by my experiences with students over the past two terms, that this approach could open opportunity for present and future audio users to voice their views and know that these were valued because their ideas led to implementation of improvements.

An issue that I anticipated might present problems and proved to be an accurate prediction was how to preserve ethics when striving to establish honest communication that would require opinions given in confidence but still pursue the path of pursuing action to improve situations that would mean questioning and being critical. The question was: How could I both observe ethics and write a true narrative account not a factual, impersonal report that schools 1,2, 3, and 4 had requested. Altricher, Posch and Somekh's (1993, p.7)

'Diagrammatic representation of the action research process' shows "making teachers' knowledge public" as a final action in an action-research project. This was helpful but a main concern was the exclusion of reference to students' opinions. This could be deliberate or unintentional but it conveys the message that the knowledge and experiences of those being taught are of less value. I wondered if a requirement should be to disseminate all participants' knowledge publicly with the

proviso that ethical considerations and diversity are respected. Confidentiality could become a major issue.

Initially I observed Derek throughout lessons to gain insight into how he could work alongside peers in lessons using audio recordings without being isolated. I prepared questions, based on incidents that occurred in classrooms to find out, informally, his views about advantages and disadvantages of the audio process and the opinions of other students in this mixed ability class.

I always carried a tape recorder but limited the amount of recordings that I made so that I was not overwhelmed with aural data as I had been during the pilot study. I wrote notes as well to remind me of details of context, body language and incidents that I observed in sessions. I noticed that some students watched me do this and wanted to read what I was writing. I changed to using a very small notebook to avoid drawing attention to this activity. I also coded names to ensure anonymity for participants (See Appendix 3c).

In accordance with the school's policy, after half term Year 8 students were regrouped into ability sets in which they would be placed until they moved into Year 9. I arranged formal interviews with Mr K, the head of mathematics, the SENCO and Derek's support teacher for dyslexia. I gave them proposed agendas and followed up meetings with written reports to keep them informed about progress and future plans. They showed little interest or enthusiasm in taking an active part in the study. The political reasons for this reaction and how different cultures of people and departments would affect the course of the investigation did not become apparent until several months later. I was disappointed that again my contact with adults was restricted to a classroom. The consolation was that the time that I spent in this 'container' with Mr D, who

was enthusiastic and genuinely interested in the research, revealed ways worth trying to facilitate inclusive learning.

A Key Incident that influenced a change in the target population for the study was when I discovered that the main cause of Derek's low achievement in mathematics was not primarily due to visual impairment. This seemed to be the opportunity I had been looking for ever since students in Mohammed's school had asked to be allowed to try using audio recordings. It was evident that accessing print information was just as debilitating for Derek, whose main difficulties were due to dyslexia, as it was for students with serious sight disabilities. I argued and won the case for expanding the population stated in my research proposal. I contemplated replacing the term VI with the term 'print disability' but decided that because I was focusing on students' abilities, I wanted to avoid words that conveyed the idea that it was their personal deficits that were causing all their learning problems. This was in keeping with the "massive criticism" of the "so-called deficit model" (Ainscow 1999, p.7).

The planning and launching of a funded lunchtime audio mathematics club that was, eventually, named CHAMPE (See Appendix 6) resulted in a productive working relationship developing between Derek, the headteacher, Mr D. and myself that was founded on collaborative communication and action. We arranged meetings at times convenient for us all.

It seemed that collaborative praxis would continue in Mr D's mathematics lessons and would become an important feature in the CHAMPE project. Altricher et al (1993 p.173) support the need for individuals to take active roles in situations, "collaborative praxis assumes that development of social practice is only possible with the collaboration of all those concerned in this practice". Additional equipment would mean that a greater number of students could be offered opportunity

to use audio and hopefully more adults would also become involved. Plans were in place for the summer term 1999. More details of strategies used and outcomes are described in Chapters 3 and 4. My role in this phase of action varied from being an observer and an observer-participant in lessons to being a participant and participant-observer when co-ordinating and piloting plans for the CHAMPE project.

## **Recess 3 Out of action (April to June 1999)**

This was a longer recess period than intended, due an extended recovery period necessary after my recent operation. There were compensations for this unwanted break in fieldwork. Mr D took over responsibility for Derek's use of the audio materials. He kept in contact with me to request new topics and text that I could audio record at home and send into school. I wrote and sent scripts for recordings. I returned to literature to learn more from theories and accounts written by philosophers, practitioners, professionals, researchers and scholars. I started to plan how to form and train a team of narrators to assist with audio reproduction.

I had plenty of time at my disposal for reflection and analysis of data gathered in phase 3 and making plans for phase 4. My decision to abandon use of the NUDIST program was further re-enforced by Winter's (1998, p.66) opinion that, "data analysis needs to be more than using one's prior set categories to classify data segments under headings, because this traps our thinking where it already happens to be". I decided to research the process of 'reflection' in greater depth. I read about the thoughts and action of other practitioners; my main interest in this recess when I was unable to put ideas for improvement into practice in schools was to develop and extend my own ability to learn from 'reflection'. Checkland and Scholes (1990, p. 286) wrote "new Constitutive Rules" based on a "decade" of learning

from use of SSM for varying purposes. The fifth rule states that:

because SSM is methodology, not technique, every use of it will potentially yield methodological lessons in addition to those about the situation of concern. The methodological lessons may be about SSM's framework of ideas, or the processes, or the way it was used, or all of these. The potential lessons will always be there, awaiting extraction by conscious reflection on the experience of use.

I had more than enough time in this recess to think back over the past year. I tried to extract "methodological lessons" that might help guide future efforts to improve situations and audio reproduction. Although I was unable to put any further ideas into action in the school I kept in touch with the headteacher as well as Mr D. by telephone. I made plans to transform production of audio materials into a more professional operation that could withstand criticism that I predicted would be levelled at it by more doubting individuals in the future.

### *Re-analysing data to discover if more methodological changes were necessary*

In School 5 one important difference was that more adults were involved in decision-making and the views of a student were being sought and taken into account by the headteacher and Mr D, who at the end of the year was promoted to deputy head of the department. Derek told me that trying to learn mathematics in secondary school was problematic and "real" for him and my initial observations in the classroom confirmed his impressions. Improvement was desperately needed to give him a chance to enjoy and fulfil his academic potential in this core-curriculum subject. SSM and action-research cite improvements as aims. I was convinced that to combine the principles of both

approaches for planning, data collection, analysis and action could bring about the desired aim for improvement not only for Derek but also for adults working with him. The question was: How would judgements be made concerning whether introduction of the audio process had made a positive contribution towards enhancing and extending his experience in mathematics and ultimately to the purpose of the research?

I had found that I could consciously reflect-in-action given the conditions in Mr D's classroom. My brief was to work closely with Derek for a few weeks to find out if the audio process was acceptable to him and his teacher. I was able to observe and reflect when Derek could depend on accessing questions and examples from audiotapes that I had prepared. I had time to question whether I was achieving a balance between tolerating undesirable situations and challenging events and dialogue in an intrusive, over critical manner that might impede developing working relationships founded on mutual trust, respect and understanding. Students' reactions varied from curiosity to total disinterest. I could not live up to every individual's expectations and judgements of my role that ranged from acting as the Borough's adviser for VI to distancing myself from internal politics and policies. Social interaction had started to expand from one-to-one communication with individual students or adults to small group discussions that entailed consulting people beyond the confines of the classroom. Social System and Political System analyses were needed in this situation as well as an analysis of the Intervention. This would be the case when I returned to taking a full and active role in developing the research when the new academic year started in September. I hoped to be able to take preventative action to avoid unnecessary confrontational encounters but I should not know if this was possible until I could return to collecting data in classrooms.



As well as planning a CHAMPE Narrating Service, I wrote guidelines for beginners to use for operating audio hardware, writing scripts and narrating (See Appendix 5). These aspects of the research are discussed in detail in Chapter 3 Mathematical Learning and examples of scripts are displayed in the Appendices. I worded more root definitions in preparation for the next fieldwork phase taking into account findings from previous practical phases.

*Root definition 4a: A researcher-owned system that, given the constraints of requirements stated for taking national tests for Key Stage 3 in May 2000, schools policies and fulfilling SSM criteria and following action-research principles, provides a service to enable students to use the audio process when taking the tests if they wish to do so and audio record mathematics revision notes for themselves when attending the CHAMPE club.*

*Root definition 4b: A researcher owned system that encourages and enables participants to contribute suggestions based on their use audio materials with the aims of (a) working collaboratively to decide on and implement changes to improve production and use of recordings (b) offering opportunity to more students to experience interest and enjoyment in mathematical education through complementary audio means, appropriate for use in a variety of learning environments.*

## **Phase 4 (September 1999 - May 2000)**

### ***Derek and other students working towards SATs and establishing the CHAMPE Club***

Other key students in Derek's Year who used the audio process in lessons and attended the CHAMPE Club are introduced briefly at the beginning of this section.

## *John*

John was Derek's friend. He was assigned to Mr D's middle-band mathematics set in September 1999. He was willing to assist Derek to access print text for homework as well as in lessons. In mathematics he tended to take his lead from Derek and rely on him to help with use of audio. He was not motivated to learn and seemed reluctant to communicate his thoughts or feelings. A videoed discussion shows his acute awareness of other people's opinions of him. He accompanied Derek to CHAMPE Club sessions and used audio recordings but the value to him of both activities was debatable.

## *Norma*

Norma used audiotapes in lessons and attended the CHAMPE Club. She formed strong social working relationships with several other students when she opted to move into Mr D.'s set to prepare for SATs. Norma liked detailed descriptions that helped her concentrate on significant features of visual displays that she tended to miss. Her willingness to speak in a videoed group discussion at the end of the year 9 gave an indication of how her self-confidence had increased. She was able to talk openly about her difficulties in reading print. She had plans for a career that required counselling skills as well as academic study. She was a sensitive listener and interested in learning.

## *Alice*

Alice wanted to remain in Mr N's mathematics lowest band set because he was her form tutor. She was trying to cope with problems with reading print and communicating clearly when speaking. She had little understanding of the topics that she was expected to know about for the Key Stage 3 national tests. She attended the CHAMPE Club intermittently but she liked to borrow audio-recordings to listen to at home.

## *Sarah*

Sarah came to the CHAMPE Club with her support assistant. She was one of the students in the school's Hearing Impairment Unit. After attending several sessions, she decided that she preferred to rely on her support person and the special techniques and equipment in the Unit.

The steps I was able to take to open opportunity for more students to use audio materials in lessons were mainly determined by professional and social working relationships already well established in the school. I needed to know more about the systems of myths and meanings that seemed to be an accepted aspect of the culture of mathematical education. Adults as well as students seemed unsure about how to relate to me in spite of carefully worded explanations about my presence in classrooms and the purpose of the study. When I entered School 5, I needed directions to different rooms and to know times and lengths of lessons. As students accompanied me along corridors we had a chance to start getting to know each other and talk about what the term research meant to them.

The process of searching for agreement through dialogue and action was problematic. No one set of equipment was appropriate for all users. Students mixed and matched accessories and positioned these in ways most appropriate for them. There were no rules or regulations about how items must be used and there was no condemnation if they decided that listening was not their preferred medium. Students who attended the CHAMPE Club began to understand the advantages of using different strategies. Derek and other students who came regularly saw their ideas being put into practice and were therefore willing to explain why they were making certain choices and decisions. For example listening to audiotapes whilst looking at diagrams and without reading text. In CHAMPE their suggestions were

displayed on a bulletin board and implemented for other members to try out (See Appendix 6c).

I adopted the role of facilitator in classrooms. I described my role as a Resource Advisor, omitting terms like researcher, mathematician and teacher that seemed to cause apprehension and resulted in participants distancing themselves from me because they felt threatened by my title. I spent a considerable amount of time consulting the Media Resource Officer (MRO) in the Print Room and using machines for production of audio recordings and copying text. This was a legitimate way of avoiding being too closely aligned with any subject department or with individuals in senior management.

The process of consulting adults who worked with the audio users was more complex. Some held deeply embedded preconceived ideas about educational research and researchers from outside coming into the school to promote innovatory ideas. I had been on the receiving end of this experience in schools. I was aware of how difficult it can be to spend time talking about one individual or idea when there are many others equally if not more deserving this special attention. I adopted a responsive, flexible role with all adults. I gave reports on students' reactions and asked for their advice in attempts to encourage their involvement in the study. Whether opportunity was not just offered to students or actively supported depended on if they were sufficiently interested to take positive, appropriate, constructive action. The adults who doubted the value of the process were unable to give informed guidance to students because they had not got to know the thinking that underpinned the research or tried using the audio hardware or software. Some agreed to listen to the tapes but when these were returned no feedback was forthcoming and it was evident that this had just been a token gesture. The only adults at

this stage convinced about the potential value of the audio materials were the headteacher, Mr D and the MRO.

A key incident that signalled a turning point and gave credence to the decision to borrow strategies from a variety of research methodologies concerned an issue of peer pressure that threatened to bring the whole study to an abrupt end. Communication and collaborative action with students and adults was necessary to resolve this issue (see Chapter 5). I gained greater understanding of how systems thinking and principles of SSM could assist resolution of complex problems. I also realised the value of applying principles from other methodologies to supplement SSM and having constructive cooperation from participants sufficiently powerful and willing to take action. I agreed with Clegg and Walsh (1998, p.232) that SSM is "a useful research tool, especially, for those working in action research mode."

## **Recess 4 (August 2000)**

I decided to abandon the idea of writing separate case studies for two reasons. Firstly many students in Derek's Year 9 had provided invaluable data through negative as well as positive participation in the study. Secondly several students in Year 8 had expressed interest in trying the audio process. The arrangement had been that Derek would stop contributing to the research after he took the national tests in May 2000. The headteacher asked me to continue the research with Stephen who was in Year 8 and visually impaired. He had responded enthusiastically to using the audio process during a pilot period in the second half of the summer term.

I had the six week summer holidays to reflect on findings from Phase 4 and update my knowledge of audio reproduction through renewing contact with people in Canada and California. I felt that I was beginning to understand the importance of being

aware, at all moments, of my own thoughts and preconceptions about people and events when words were being uttered and actions were in progress. By standing back and reflecting on what was being said or happening before I took an active role, I had discovered that problematic situations could be resolved without adult intervention. I applied this strategy in interviews resulting in a more relaxed atmosphere that enabled easier, more open communication. The main reason that people in secondary schools gave for refusing requests to take part in the study was time pressure, but the headteacher, Mr D and Ms A although in high power demanding jobs had always managed to give full attention to subjects under discussion and follow this up with action. When students realised that responsibility rested with them I was amazed by their mature dedication to fulfil their commitments. Key incidents that led to learning for us all are described in Chapters 4 and 5.

Offering more students opportunity to use the audio materials in lessons created a more complex challenge. I was uncertain of the reasons why managers and members of the mathematics department appeared to be undermining the constructive, creative input that Mr D had contributed to the research and CHAMPE project before his departure from the school in July 2000. The message being communicated to students was that the audio process was intended exclusively for students who were failing in mathematics. I referred to Political System Analysis and words of warning from experienced practitioners about abuse of power to plan for facing further difficulties likely to arise from differing personal and organisational ideologies, for example the comment by Clegg and Walsh (1998, p.231) that "powerful stakeholders can resist and veto change". My concern was that powerful professionals might succeed in closing opportunity for more students to find out if the audio material might enhance and extend their experiences in mathematics. As noted earlier, Checkland et al (1990) claim that applying SSM

thinking to the three forms of analyses is never ending. I had no idea at this point that insurmountable barriers would be erected in the following year or how people in positions of power would react to an innovation, if they perceived it as a threat to their authority.

In Canada I updated my knowledge of audio reproduction at the Alternate Format Resource Centre. I consulted people in California with whom I had maintained frequent contact since 1998. I realised that I was in the midst of theorising an exciting, essential process that I refer to from this point onwards as 'reciprocal learning'. In phase 5, I planned to consciously explore the value and implications of receiving as well as giving knowledge, skills and benefits of past experience, when interacting with young people and those assumed to be less well informed or able. Stephen was the main actor in the final stages of this study but adults working with him and other students made invaluable contributions to the research.

I constructed a root definition to describe a system that schools claimed to be operating. In Phase 5 I wanted to find out whether this was in place in settings other than Mr D's classroom. At the end of the summer term Stephen and eight other students had been told that they could use audio materials in lessons and then use this method for taking Key Stage 3 national tests in May 2001 as Derek and others in his year had done in May 2000.

*Root definition 5: A researcher and student-owned system that, given the constraints of requirements stated for taking national tests for Key Stage 3 mathematics in May 2001, schools' policies, fulfilling SSM criteria and following action-research principles offers opportunity to all students to try using audio materials to extend and enhance their*

mathematical experiences and develop and improve audio production and change the CHAMPE club into a loaning library.

## **Phase 5 (post May 2000)**

### ***Stephen and other students***

Key students who contributed to the study during the period that Stephen was involved are introduced briefly at the beginning of this section. More details of their stories are given in later chapters and in Appendix 1.

### ***Jeremy***

Jeremy, one of Stephen's friends contributed to discussions, designed a poster displayed in the school and assisted with the re-organisation and running CHAMPE as a library. He was in a top maths set. He found writing solutions easier than oral explanations. He persevered with tasks required to obtain a Mathematics Certificate for assisting students up to level 4 in Key Stage 3. One of the requirements was to script and record two topics. He was reliable and conscientious and was appointed a school prefect.

### ***Alistair and Jack***

Alistair and Jack were suggested as participants by Ms L. an experienced teacher working for additional qualifications in literacy for students with 'dyslexia'. Both students attended CHAMPE and used audio means out of the classroom but without encouragement and interest from other adults, they chose to go on pursuing the way of learning through print means alone, like their peers. They apparently felt that there was more safety in sameness in the classroom.



## *Jeremiah*

Jeremiah chose to borrow recordings to take home so that he could listen to them several times, this was the feature he liked. When he tried this in lessons his teacher described it as 'playing with the equipment'. He reverted to spending his time chatting with other students and giving up the idea of persevering with the idea of trying to help himself learn mathematics.

## *Alec*

Alec did not join Mr I's class until towards the end of the of the summer term. He found listening to the recordings helpful but he could not tolerate anything on or in his ears. He was enthusiastic about using audio for SATs but he was one of nine students who had the offer withdrawn from the beginning of the term preceding the SATs.

## *Matthew*

Matthew asked me if he could try using an audio approach in the classroom. His teacher Mr I. supported the process but thought it was a 'novelty' for Matthew rather than a 'necessity'. Matthew liked to be the centre of attention and tended to disturb lessons, but when he realised that I was listening to his comments and taking them seriously, he began to talk openly and honestly. He gave an emotional account of his experiences after he had taken SATs without use of audio means. He wanted to continue complementing his mathematical learning through this medium. He was another student of the nine for whom a promise made was broken.

## *Teresa and Vivienne*

Teresa approached me during a CHAMPE session, after it had been re-launched as an Audio library in the Main School Library. She

asked if she and her friend Vivienne could become assistants. The two year project was nearing its end and there was no official school co-ordinator. The Senior Librarian suggested that CHAMPE should be run as a student initiative. A period of creativity and enthusiasm ensued. Neither of the girls cited maths as their favourite subject. They were in different sets but had formed a close friendship based on their complementary strengths. They shared an interest in making maths more fun and enjoyable and were thinking towards careers in teaching and working with younger students. They suggested more ideas than they actually put into practice.

### *Daniel*

Daniel initiated communication with me whilst I was working in the Print Room. He asked if I wanted help with technology for CHAMPE and I accepted his offer, enthusiastically. Daniel took on the responsibility with commitment and dedication. He showed determination to overcome every challenge that arose during the following months when development revolved around creating a CHAMPE website.

I observed Stephen in Mr I's classroom in the spring term 2000. In this set, difficulties ranged from anti-social behaviour to Stephen's problems associated with his serious sight impairment. He was keen to try using audiotapes. The students were following SMP individual programmes. They were expected to conform to the general rules of the school displayed in the classroom but there was little expectation or pressure on them to progress academically or do homework. Students in this set were encouraged to speak freely but there was little sense of purpose or enthusiasm for gaining mathematical knowledge, applying this or acquiring new skills. These students knew that they were in a bottom set and responded accordingly. I was a participant observer for only a few weeks in this classroom. It seemed that confrontation with other students who were

sometimes disruptive was avoided at all costs. The abilities of quieter students, like Stephen, appeared to be underestimated judging by the topics on their individual programmes.

When I first talked to Stephen on his own I was "self-revealing rather than remotely authoritarian" (Wahl, 1999, p.224), but he did not voice his views candidly until we had worked together for a year. He was more at ease talking in the library than in an unoccupied room. He described how he had coped during the first the two terms in secondary school without adult or audio support:

*not really very well. I used to get all my mates to help me out and read things for me off the board ... I think they got a bit annoyed sometimes because like they were getting a bit far behind in their work. They were helping me as well as doing their own work. So, in the end, I used to let them do their work and when they'd finished I asked if anyone would help me do as much as I could of my work.*

Stephen was reticent about discussing mathematics. His mother confirmed my impression that he felt he was failing in this subject. He was blaming himself for all difficulties he was encountering. He was unable to see print displays in red and needed text and diagrams enlarged to stand any chance of completing tasks within time allowed in lessons. Glasses did not provide the solution. He had no Statement, no individual support and there was no VI Adviser in the Borough. He was keen to learn but as well as relying on his peers for access he often required their help to tackle mathematical topics that he was assumed to have understood at an earlier stage.

Stephen was assigned to Mr N's set at the end of term when all Year 8 students were re-grouped into ability sets. After nine lessons Mr N recommended that Stephen should be moved into a top set. For the remainder of the term his teacher was Ms P.

She welcomed introduction of audio materials into her classroom to improve learning conditions for Stephen and any other student who could benefit. I was again privileged to be in an environment where a collaborative way of working was accepted and supported by a teacher. Stephen did not find the move into a top set easy but it seemed as if he was gradually adjusting to being in a setting where expectations were high and discipline strict.

In September the sets were reorganised and Stephen was again placed in Mr N's set. The managers of the mathematics department did not state the assignment of students to mathematical sets until the term had started in September 2000. The eight students who had also opted to use audio materials had been placed in four other sets. A promise had been made that, like Derek, they could take SATs using audiotapes if this was the method they used in lessons. I was trying to provide support and advice, in four classrooms, for these students as well as Stephen and adults working with them within the hour allocated for mathematics lessons. I found the task physically impossible. This was my first experience of handling misuse of power without Mr D's assistance. My requests to make changes in the organisation of sets to allow a promise to be kept were ignored in spite of my verbal and written requests. The headteacher remained committed to the aims of both the research in classrooms and CHAMPE but she was apparently powerless to insist on change. I did not know that she was leaving the school at the end of the year.

As Winter (1989, pp.186-194) states "some clients afford us more fulfilment than others". He asks crucial questions concerning ideology, "What resources, then, do we have for discovering a 'truth' beyond ideology?" and how can we go "beyond competing ideologies, to offer possibilities of changes in our thinking and in our practices? Is this possible? And if

so what sort of procedures and changes are we concerned with?" It was evident that most of the students named by teachers to attend the CHAMPE club were still individuals regarded by adults as failing in mathematics for reasons ranging from being disruptive to lacking motivation to learn.

I returned to the main purpose of the research and the emerging intention to explore the process of reciprocal learning. I decided to concentrate on encouraging and enabling students to make explicit their own ideas and concerns, with the aim of improving and developing audio production, distribution and use for the CHAMPE Audio Library/Club that was to be launched during the term. I had no remaining resources to tap to bring about changes in thinking or practice related to inclusiveness being prevented from happening in classrooms. My only choice was to accommodate to working under the same conditions as Stephen and the other students. The MRO continued to provide advice and support for the students, the study and me. I was committed to continuing to offer opportunity to everyone interested and to play a positive and productive part in improving audio production and enhancing their own mathematical experiences. I had hoped that audio process would enable students to have control and agency over their own learning in classrooms but the only environment in which this was possible was in the Main School Library. In this setting the Senior Librarian actively supported and promoted the CHAMPE project and the process of reciprocal learning.

### *Thinking about the future*

I was transforming my existing theory about the potential for using audio recordings to enhance access to the mathematics curriculum into a theory concerning reciprocal learning. I hoped that this way of learning that had emerged from applying strategies from various research methodologies combined with practitioner experience would be permitted to thrive and

survive. Fortunately I had been forewarned that although many months had been spent in introducing and developing an innovation intended to benefit students the whole process could be destroyed in a matter of moments by people or events that affected progress so that problems became crises of confidence. As I write this account the process of reciprocal learning remains unexplored in-depth and in a wide enough range of environments. It will require sufficient interest and practical support to allow it to develop to its full potential. I believe that it could provide deeper insights and understandings of how a different approach could enhance and extend all learning not just in mathematical education. In the following chapters I describe how I discovered the value of applying a reciprocal learning approach to complement other methodologies, as I developed themes that emerged from the key findings of the research.

# Chapter 3: Audio means for accessing and enhancing mathematical experience

## Purpose and Structure of Chapter

In this chapter I shall describe and explore what I learned from my attempts to introduce and develop use of audio materials to complement, enhance and extend mathematical experience of participants. Research that started with mainly technical considerations raised issues related to the thinking and implementation of action by students and adults involved in the pedagogy of mathematics. My thinking concerning the nature and scope of the study changed as a result of my practical experiences in schools. I had not anticipated at the outset how some people's reactions and unexpected external elements would affect outcomes. Surprising events resulted in the necessity to concentrate not only on use and production of audio recordings but also on mathematical content and presentation. I discuss how a production cycle evolved as practicalities and implications of the process became evident. The focus remained on facilitating inclusiveness for students attending mainstream schools. The importance of developing collaborative communication and action became increasingly apparent.

Initially I concentrated on production of audio-recorded materials for students with visual impairment to use in lessons but I was asked in some schools to withdraw them from classrooms, as explained in Chapter 2. I agreed to organise the extracurricular project (CHAMPE) in order to obtain funds to purchase more audio items. I wanted to open opportunity to other students in School 5, who were encountering difficulties in accessing information in print and asking to use the audio recordings.

I show how providing access to printed information led to discovering complex features inherent in teaching and learning mathematics and awareness of practices that sometimes conflicted with my previous learning experiences as a practitioner. It also resulted in me questioning and comparing my philosophy of mathematics and mathematical education with the beliefs, values and intentions of others and re-examining how personal opinions might have influenced data collection and analysis. Mercer (1995, p.3) mentions the difficulty of separating "the thing being studied – from the methods used to study it." I was interested in how mathematical knowledge and skills were being shared between students and adults to facilitate understanding, as well as getting to know how students were endeavouring to make sense of mathematics. I examine the effects on preparation and use of audio recordings to complement learning that resulted from directives on schools concerning which mathematical knowledge and strategies should be taught. Throughout the study I continued to extend and update my knowledge about mathematics and mathematical education and identify extraneous factors that were affecting what was happening in reality.

In the first section I explain reasons for choice of audio equipment for students to use in lessons, details of how recordings were produced and requirements for narrators and people writing scripts.

## **Preparing for audio reproduction**

### **Hardware**

Before I introduced audiotapes into schools, I searched for a low cost machine suitable for use in mainstream classrooms, with the facility to record good quality speech with minimal background noise. The essential features of hardware based on requirements of listeners and narrators are listed in Appendix



7a. I chose tapes because CD and DVD players were too expensive in 1998. The cost to replace or repair lost or damaged machines and to insure these portable items was prohibitive. At the beginning this was a small scale, self-funded study. I hoped that schools would eventually take over responsibility for the audio process but I knew that departmental budgets were already overstretched. It was unreasonable, without a trial period, to expect financial assistance for an innovation that may only suit a small number of students. I updated my knowledge about audio technology. I wanted to benefit from the experiences of others in the field of audio reproduction.

I consulted people in well-established organisations in the UK and abroad<sup>10</sup>. Most production units that I visited provided complex up-to-date equipment for producing, copying and storing high quality sound recordings. Some studios were equipped with sound proofed rooms or closed cubicles with a staffing level that made it possible for a person to monitor narrators as they were reading. I took into consideration conditions under which narrators might be making recordings. In mainstream schools even a small quiet room was generally unavailable and volunteers might prefer to work at home where space was limited. The environment in which narrators would read scripts influenced selection of hardware.

Students with visual impairment in mainstream classes required a recorder that was easy to operate, durable and with sound quality suitable for the environments in which they would be

<sup>10</sup> The Queensland Narrating Service and the Round Table on Information Access for People with Print Disabilities Inc. (Australia); the Alternative Format Services (Canada); Recording for the Blind and Dyslexic (USA); Bradford Talking Magazines; Cotis and RNIB Services.

studying mathematics<sup>11</sup>. The Sony audio tape-recorder that I purchased in Australia had a facility for inserting tones on tapes to enable listeners to select the start of questions and sections. A high-pitched bleep could be heard over the 'chipmunk effect' that was heard when the fast-forward or rewind key was depressed simultaneously with the play key. Research into the field of indexing tapes indicated that a better system for scanning a tape to find information had not yet been invented. A few months after I returned to England, I found an electronics retailer in London that had started to stock the same model of recorder manufactured by Sony. I was fortunate that a salesman who specialised in audio technology was willing to pass on his extensive knowledge about advantages and disadvantages of different types of recorders and accessories.

Safety and economics were the prime concerns when selecting power sources for recorders. The long mains lead in Linda's classroom was a safety hazard. An alternative source to ordinary batteries had to be found because these were expensive to replace. Users frequently forgot to switch off equipment before they returned recorders or took AA batteries home to replenish their own supplies. The battery re-charger available from the RNIB was designed to discharge rechargeable batteries before recharging them to lengthen their life. Recorders and batteries were marked with numbers and the name CHAMPE to make them easy to identify and check for recall after loan. Small battery testers were used to check power levels. Other hardware

<sup>11</sup> Sound quality was too poor from the Sony pop-up internal microphone. Directional microphones were expensive and those with batteries likely to be left on. The tie clip microphone produced best quality sound and were inexpensive and portable. Persula, a charity organisation permitted bulk buying tapes because students with VI would be using the tapes. C20 and C120 were unsuitable lengths for recordings. C60 was main type with C90 used for revision and tests and interviews. J. Henkelman (2000, Canada) warned that tapes would be discontinued soon.

considerations for production of audio materials concerned choice of external microphones suitable for recording environments and sources of tapes and batteries<sup>11</sup> that were economically viable. The equipment purchased for listeners and narrators was easy to assemble and return to protective containers.

It was important not to impose segregation on students by interfering with the social side of mathematics. Dual listening, using stereo earphones with the mono recorders was possible providing students handled these carefully. Mono ear and headphones were cheaper but less comfortable. A single jack inserted into the socket on the side of the recorder allowed stereo listening devices to send sound to both ears but if too many devices were plugged into a recorder, connections were unreliable and unstable. This drawback proved to be an incentive for handling equipment carefully.

## **Production cycle**

Analysis of data collected whilst piloting use of hardware and software with students had highlighted the need to know, well in advance how items would be used and ways production could be improved. I researched methods of verbally presenting mathematics to students working at levels of mathematics higher than those working towards the national tests at Key Stage 3. To safeguard confusion for students later in their studies, I needed to be familiar with the conventions for introducing mathematical vocabulary and strategies to students studying topics at degree level. Andrew Hart was my most knowledgeable source of practical as well as theoretical information about scripting and narrating mathematics. He is an Australian, who is blind and trained narrators to assist him in his studies for a PhD in this subject. He produced guidelines in 1997 based on

his experiences. Guidelines produced by other groups were helpful but offered no specific advice about scripting or narrating mathematics. Larry's Speakeasy, 'Handbook for Spoken Mathematics' (Chang, 1983) written for students working towards degrees in mathematics served as a discussion document for writing scripts, in conjunction with recommendations in the NNS.

Audio reproduction proceeded in cycles involving discussions, decision-making and implementing ideas that were subsequently reviewed and improved. Figure 3.1 shows the production cycle:

Deciding what to record → obtaining print copy → getting publishers' permission → agreeing on presentation → writing scripts → making recordings → using recordings → reporting back → analysis → reflection → implementing improvements → putting ideas into practice

Studios were a long distance from schools that were ordering recordings. Script-writers and narrators in these production units did not request direct feedback from young people nor did they visit the different educational settings in which recordings were used. I was planning to involve students in production of audio materials as well as use. Susan Crowe relied on feedback from listeners to improve the Audio Service that distributed magazines in Bradford. She provided invaluable advice about obtaining feedback from listeners and the potential use of audio technology for the future.

The activities described in the following sections relate to how production and use of audio materials affected mathematical experiences and how teaching and learning mathematics influenced selection of ways of preparing and using audio reproducing.

## Making recordings

### *Content and presentation*

The National Numeracy Project (DfEE, 1996) was being introduced into selected primary schools. One of the requisites was a "numeracy hour" with time allocated for independent work. By the time I had finished fieldwork, the project was known as the National Numeracy Strategy (NNS) (DfEE, 1999) and had been extended into the first three years of secondary education. Strategies as well as content and language for lessons was recommended in this document.

In accordance with copyright conditions, exact words were read from print in textbooks. Only the author and publisher of the Mathematics Level by Level scheme (Stafford, 1998) permitted use of alternative and additional terms and strategies in audio recordings. Other publishers restricted use to a limited number of named students. I consulted teachers about worksheets they had produced within schools. I was obliged to record material that they selected for lessons to enable students who opted to use the audio process to participate in learning alongside their peers in classrooms.

Narrators needed to state page numbers, to enable listeners to follow instructions given in lessons. This was necessary because teachers often worked through examples with the whole class and then set exercises by giving a page reference. Scripting questions from textbooks or test papers was not so problematic concerning wording but needed discussion about presentation. One change made was to announce marks awarded for answers in examinations before instead of after questions. This was done to avoid disadvantaging listeners who could not glance at this information to help them decide how much time it was sensible to spend working out an answer. It was evident from observing students in lessons, that for multi-part questions,

it was easier if the initial instruction or sentence was repeated at the beginning of each part. This avoided the need to rewind the tape, which took much longer than scanning by sight. Choice of language for recordings required frequent rethinking in response to feedback from students. General agreement had to be reached on whether to offer several alternative strategies or suggest only one way of showing working with constant reminders that listeners should try their own ideas.

A system was developed to guide audio production. I applied methodological principles from SSM and action-research supplemented by other methods discussed in Chapter 2 to guide debates and implement decisions. Systems thinking was used for learning purposes and acted as an incentive to improve audio recordings. We were not searching for one optimal solution. I gained further insight into the process of collaboration and its value for obtaining and analysing all viewpoints (See Chapter 2, p.119). The theories that emerged from sharing ideas were put into practice and the cycle was repeated many times. Written guidelines (see Appendix 5a and 5b) for future audio users and producers were based on discussions with students and adults. A major concern was not to provide too much or too little information. Guidelines were updated regularly and are still open to change.

When Derek was assigned to Mr D's class, he progressed to being a quick competent listener who preferred brief descriptions of graphical and tabulated displays but needed questions and new terms read aloud. In contrast Norma liked detailed descriptions that helped her concentrate on significant features of visual displays that she tended to miss. Unnecessary verbal descriptions confused rather than clarified ideas or assisted understanding. This also deterred some students from listening. Mason (1989, p.154-155) addresses a similar issue when he

questions why his daughter ignored the picture of a two-wheeled bike in her textbook and only concentrated on getting the answers to the multiplication sums correct. In this case it was pictorial not aural information that was superfluous. He asks, "What did she make of the task? What did the author intend her to make of it? the question – what is going on inside their heads? – is endemic to teaching". These queries applied to script writing but the dilemma for us, like authors, was trying to produce materials appropriate for many students not an individual. When producing material for listening purposes decisions about omitting unnecessary information had to be made to avoid adding to difficulties. There were many occasions when I should like to have asked authors why they included certain diagrams and pictures. An example was the numerous signs shown in a picture of a reception area in a textbook that Linda used in school 2. These were unrelated to the questions and confused rather than clarified information given.

The wide-ranging copyright permission granted to audio reproduce the Mathematics Level by Level scheme allowed action to be taken about including reference to the experiential world. This was important as:

mathematics is a discipline perhaps uniquely based solely in text and concepts, which does not describe or refer to the experiential world except indirectly ... problems arise from the strong objectivity of mathematical language which excludes all references to persons, places and events.

(Ernest 1997, p.80)

In the introduction to the topic 'approximation', value for money when buying and selling a mountain bike was given as an example instead of only numbers and symbols. Dowling (1993, p.39) criticises this approach using a question in the 'G' series of SMP 11-16 textbooks (SMP, 1997) as an example. He

describes the problem as "parading as a 'real life' problem, but is in fact, structured according to the curricular needs of mathematics". This was one of the published schemes that we audio recorded for students in school 5. Despite Dowling's criticism we continued to incorporate 'real life' problems in recordings in response to positive responses from students. Students enjoyed hearing information of general interest included at the beginning of some topics on recordings made. For example the brief talk about temperatures that was included in the introduction to negative numbers provoked interesting discussions as students were working.

Stubbs (1987, p.xi) acknowledges the complication caused by the official mathematics shorthand system of communicating through symbols and abbreviations: "mathematical reasoning depends on abbreviations and symbols, which require written notation for their development and do not transfer easily to spoken language." Deciding on wording for scripts revealed a wide variation of interpretation of meanings of symbols. For example a short horizontal line between numbers in print might be read as take away, subtract or difference between the amounts. Mohammed and Derek tended to misread symbols adding supporting evidence to the fact that "there is a great disparity in the range of conceptions of mathematics ... a consequence of this great variation is the lack of communication, misunderstandings and affective problems concerning mathematics" (Ernest 1994, p.81). This disparity led, naturally, to talking with adults about ways in which they were communicating with students in classrooms and questioning how they had arrived at decisions that they were putting into practice for interpreting mathematical symbols, language and descriptions of diagrams. Criticism was expressed in some instances about fourteen-year-old students, who looked at a diagonal cross and talked in terms of 'lots of' or 'times' instead of the taught-term



'multiply'. Other adults held the opinion that this was acceptable.

An issue never resolved was how symbols could be interpreted, verbally, without advantaging or disadvantaging examination candidates or undermining what was being tested. I discussed suitable wording for examination questions with professionals who had contributed to compiling the NNS. I was concerned about embellishing information when reproducing information in an audio medium. There was a considerable difference of opinions about how to script and read symbols in the amounts "35% of 70ml" and entries on a bus timetable "08.40 and 10.05". These were two examples that appeared in print presented to students working towards Key Stage 3 national tests. This was an indication that there was no complete agreement amongst professionals regarded as experts in the field of mathematics.

The necessity to make interpretations explicit revealed the fallibility of the linguistic aspect of mathematics amongst adults as well as students. The Qualifications and Curriculum Authority (QCA, 1999) was responsible for production of the print copies of the national tests but could not offer clear guidance about audio reproduction. An offer to send a sample audio version of papers that students were using for revision purposes was refused. I knew from my previous experience that the language used by amanuenses in support work and examinations was variable and was rarely, if ever, monitored. I reasoned that, with the amount of thought and discussion that had been devoted to producing audio recorded papers, a stage had been reached by May 2000 where they would be appropriate for most candidates.

### *Narrating*

One of the conditions attached to the funding award for the CHAMPE project was that younger and older members of the local Community must be involved. The oldest narrator was aged

ninety. The learning from the experience of working across generations in order to produce audio materials for student listeners is described in Chapter 5. Participants, including myself, discovered that:

one force of talking aloud is that it requires the use of words, whereas merely thinking to oneself allows words to be bypassed. It may be only when you discover a difficulty in expressing what you want to say, that you realise that things are not quite what you thought.

(Pimm 1987, p.25)

One of the uses of making a recording was that it provided a legitimate reason for talking aloud in mathematical language. Pimm (1987, p.197) observes that, "one of the difficulties resides in the fact that the grasp of meanings precedes verbalization and that words per se are not the message, but only one of the possible vehicles for the message." This was one of the problems that deterred volunteers from narrating mathematics although they were willing and able to audio reproduce literary works. When the reader does not really understand and is unfamiliar with technical terms reading with interest and flow is unlikely to happen. In the publication 'Children Reading Mathematics' (Language & Reading in Mathematics Group 1984) the approach used by a Russian teacher, Petrova, is described. Pupils were asked "to read problems out loud and to convey meaning through the manner of reading" (ibid p.152). Examples of some of the questions that provoked much discussion when writing scripts are given in Appendix 5c. Students reading from text in lessons also found these particular questions difficult to understand. The confusion about meaning of a question about balancing equations was recorded on a video recording of a lesson in school 5.

An additional skill for narrators was to insert tones and taps, and judge length of pauses between groups of letters when spelling new terms or number operations to allow enough time for writers who used Braille to write these down.

### *Recording skills*

The skills required to audio record mathematical text and describe diagrams were similar to ones required by adults sharing their knowledge and strategies with whole classes or individuals. The audio process provided a justifiable reason for discussing and developing these skills. Critiquing speech was not on the mathematics curriculum but if speech was unclear or too fast, listeners were unable to hear what was being said. There was an obvious reason for analysing ways of speaking and implementing changes in order to improve audibility that it was hoped would lead to increased comprehensibility. Webster (1998), with years of experience in the audio reproduction field, ran a course for narrators in Australia and advised: "NEVER sight read the text. Text MUST be prepared beforehand'; pay attention to how you breathe and vary speed and pitch of your voice; speak words with letters 'P' or 'S' carefully to avoid causing a popping or whistling sound for listeners; vary pitch and tone to add interest for listeners" (See Appendix 7). The added incentive, in school 5, to speak clearly was the presence of students with hearing impairment who attended lessons in classrooms when they were not working in the special unit. Only a small percentage of the adults and seventeen hundred students in the school seemed aware of general difficulties caused by hearing disability. No particular attention appeared to be given to additional difficulties caused by the peculiarities and similarities of the sound of some words in the language of mathematics.

After students had tried out equipment and ideas, knowledge gained and skills developed were shared with people in other

schools and the volunteers in the Narrating Service. I ran training sessions for all individuals who wanted to audio record mathematical material for themselves or others. I was impressed by the determination of all contributors to persevere and succeed in making high quality recordings. Dual and single voice recordings were produced.

## **Introducing the audio process into schools**

### **Explaining aims and roles**

Entering unfamiliar environments is a daunting experience. I arranged initial meetings with students and staff in schools, on an individual basis. I stressed that the audio recordings were being offered to selected students to help with research. I kept reminding participants that the audio process was not intended to take over the teaching process; students were trying out a complementary medium to assist accessing print information. Self-check recordings were being produced to assist students to reinforce and revise topics. I assured all individuals that I would include their ideas about how to explain the aim of the research and my role, when I introduced the audio process into classrooms. In spite of my reassurances, from reactions to my presence in classrooms and lack of interest in taking a pro-active role in the study, I got the impression that many members of staff seemed to think that I was encroaching into their territory and that my real agenda was to criticise their work. Only Stephen's teacher, Mr N in school 5, told me his view that he preferred not to have another adult in his classroom. I could understand suspicions and distrust of outsiders and innovatory ideas, knowing that members of staff felt that they were under constant scrutiny, with criticisms from previous inspections of their ability to fulfil their present commitments and prospects of more official visits.

Burton's (2001) observation concerning teachers of A Level students also applied to teachers endeavouring to implement the NNS to prepare younger students for National Curriculum tests:

it is not that teachers are unwilling to create classrooms of the kind that students value. They feel that time pressures, overfull syllabi ... and lack of an underlying epistemology which respects participation and creativity, rather than reproduction, precludes them from teaching in the ways they would like to teach.

(Burton 2001, p.68)

I empathised with teachers. My concern was that concentration on students' levels of attainment within set time limits and obtaining correct answers through prescribed methods was being prioritised, instead of working towards understanding concepts. I emphasised that any additional demands that I might make on adults who took part in the study, were open to question and that acquisition of mathematical knowledge was only part of the purpose of the process.

In Schools 3 and 4 where I started the main study, participants seemed unsure about how to relate to me. In School 5 I eventually assumed the title inspired by a question from a student who asked if I was the "audio-teacher". Being an audio-teacher was apparently acceptable to everyone including members of the mathematics department. In this role I could enter and leave classrooms without disturbing lessons. No one took notice as I looked at print materials or watched and listened to them working. I explained to all audiences that listening to audio recorded text enabled some students to progress with greater speed and ease without constant recourse to teachers and peers. Individuals and groups gave the impression of understanding the advantages of this approach. I stressed that not everyone would

find listening easy or helpful and that it was possible to discontinue involvement after a trial period.

I organised induction sessions to enable students and adults to acquire essential skills. I gave intensive input at the start to introduce essential skills for operating audio hardware and accessing information, independently, through listening and then supported the process in classrooms. Students like Matthew learned basic skills for operating the recorder in less than an hour but learning to listen took much longer. I gradually decreased support, as students became competent and confident users of the audio process. Specific examples of learning that resulted from these one-to-one sessions are described in Chapter 5.

## **Differing thoughts and practices**

The prime purpose of listening to adults sharing their knowledge and skills in classrooms was to note terminology and language they expected students to understand, so that familiar words and explanations would be on audio recordings. A critique of teaching was not intended. It was possible to pursue this aim when preparing a recording for one student but more complicated if it was to be made available to several individuals. How the implementation of the NNS affected inclusion of students learning mathematics in classrooms is described in Chapter 4.

I had not expected to delve so deeply into the realms of analysing spoken and written mathematical language. Writing scripts and narrating had highlighted the need for audio users and producers to understand facts, instructions and questions that were being communicated to them and to be able to reciprocate in similar comprehensible terms. Whether and how individuals managed to tackle the challenging task of communicating with each other seemed to depend to a large

extent on their personal ideologies and philosophies. Adults' willingness and ability to create an environment, within which inclusiveness was supported through use of the audio process, appeared to be linked to differing personal ideologies and philosophies of mathematics. For this reason, in the following section I refer to mathematical philosophies that were particularly relevant to this research and may have strongly influenced the thoughts and actions of any of us who took part in the study. The effects of organisational ideologies were also in evidence and could not be ignored.

## **Ideologies and philosophies**

The change in curriculum ideology when the NNS was introduced into schools influenced thinking, production of materials and whether students were given a chance to find out, in classrooms, if the audio process was beneficial for them. There was a noticeable swing away from individualised mathematics schemes towards whole class teaching in attempts to conform to the time allocation advised for activities in lessons.

The amount of data that I could collect about personal philosophies of adults through direct communication depended on the time that they were able and prepared to spend discussing this. My main task in classrooms was to observe and try to understand what it was like for students having only limited access to print information. I was reluctant to withdraw students from lessons but in some instances I was given no option. It was during these one-to-one sessions and as organiser and coordinator of the CHAMPE Club that my personal philosophy of mathematics came into question. It was necessary to review and plan content and presentation of recordings and keep in close communication with teachers. The Club/Library was formed for students to attend, voluntarily, in their free time to use audio materials for mathematical activities. Social and personal development of participants was an integral part of

this project in combination with enhancing and extending mathematical experiences during breaks and lunchtimes. I was fortunate that none of over fifty students refused to talk to me and appreciated having a chance to express their views.

Examples of informal comments that helped explain why people were employing particular approaches when working with students came from Thomas' IST and childminder who recalled their experiences of rote learning and traditional teaching in mathematics that caused them to doubt their own ability and avoid the subject after they finished their education. In contrast Mr D was practising mathematics in business before embarking on academic study of the subject. His enthusiasm, interest and openness to making changes benefited all his students. Introducing the audio process highlighted the tendency of many adults to cling to traditional techniques for teaching mathematics and unwillingness to change their thinking or actions. Mr D with his zest for trying new ideas and Ms R with her sincere interest in the subject and both prioritising the students' interests and desires were the exceptions. I could not prevent my own philosophy from affecting how I responded to social and educational issues but I spoke, openly, about my interests and beliefs. The pedagogical consequences of strongly held views were evident in classrooms where students were the captive audiences of one adult, usually for at least a year of learning in this subject.

Ernest (1991, p111) discusses the links between philosophy and mathematical education, "different philosophies of mathematics have widely differing outcomes in terms of educational practice. However the link is not straightforward ... an ideology is an overall, value-rich philosophy or world-view, a broad inter-locking system of ideas and beliefs." I discovered that knowing the thinking that underpins different philosophical views is essential when analysing data collected concerning



what is taking place in classrooms and why. Ernest (1991, p.114) states that, "the main distinction in the philosophy of mathematics is between absolutism and fallibilism." I kept in mind ideas that underpinned these two schools of thought as I observed and participated in situations.

### *Absolutism*

Ernest's (1991, p.7) interpretation of absolutism in the area of mathematics as knowledge is, "that it consists of certain and unchallengeable truths". In his later writing he adds to this view that:

absolutist philosophies of mathematics thus have internalist concerns and regard mathematics as objective and free of ethical, human, and other values. Mathematics is viewed as value neutral, concerned only with structures, processes, and the relationships of ideal objects, which can be described in purely logical language.

(Ernest 1998, p.270)

This is an essentially positivist approach and was in evidence to varying degrees in most classrooms, especially in secondary schools. Getting right answers was a priority for both students and adults with rewards ranging from verbal praise, ticks and merit awards to announcements of results of tests in the order of attainment. This procedure was satisfying for students able to succeed but devastating for those unable to gain high marks or work within a rigid, inflexible structure imposed on them. Adults' interest, commitment and ability to communicate to students, not only mathematics facts but also positive feelings about the subject, with sensitivity and flexibility, influenced how students reacted and responded. Derek was disadvantaged mainly through inadequate provision to assist him manage the difficulties of dyslexia. Thomas was struggling, without sight,

to participate fully in mathematical activities. Both demonstrated real distress when their answers were incorrect. During the first weeks Derek's immediate response when his strategy differed from one explained on an audio recording was "I've done it wrong". Thomas was too worried to use his Braille machine to write down answers in case they were wrong. These are just two examples that illustrate how conveying the message that mathematical knowledge consists of 'unchallengeable truths' can adversely affect learning and result in associating mathematics with negative experience. If this undesirable situation is ignored it can cause a lifelong dislike and fear of the subject, as demonstrated by older members of the community who enthusiastically agreed to assist with narration until they knew that they would be reading mathematics.

It is easy to condemn adults in schools for retaining the practice of concentrating on correct answers but in the national tests for Key Stage 3 mathematics few of the answers were awarded marks for showing working. Like computer marked papers in higher level examinations the old adage that in mathematics answers and strategies are either right or wrong is in danger of continuing to pass, without change, from one generation to the next.

### ***Fallibilism***

Ernest (1991, pp. xi-xii) describes the characteristics of the fallibilist school of thought that had particular relevance to this study:

mathematics is fallible, changing, and like any other body of knowledge, the product of human inventiveness ... such a dynamic view of mathematics has powerful educational consequences ... those of us in education have a special reason for wanting this more human view of mathematics. Anything else alienates and disempowers learners.

Mohammed and Derek were two students who gained confidence when they realised that mathematics is fallible and inventiveness is permissible. At first they questioned only the audio equipment and production of recordings but eventually they applied this critical thinking to mathematics. For Mohammed this began happening when I withdrew him from lessons. Derek and other students in school 5 gradually realised the fallibility of mathematics through Mr D's approach in the classroom and in the CHAMPE Club where inventiveness was encouraged and valued. They needed encouragement and reassurance to voice their views and realise that they possessed the power to access and use information, request guidance when required and be instrumental in making improvements. Thinking in terms of political systems analysis (See chapter 2 p.60), I was aware of how students perceived deployment of power according to positions held by adults in schools. The task was to try to change these perceptions.

### **Relativistic fallibilism**

The detailed description of relativistic fallibilism given by Ernest (1991) contains social aspects of this mathematical philosophy that were particularly relevant to the thinking that underpinned my study:

two of the central themes of this ideology [relativistic fallibilism] are society and development. Knowledge and values are both related to society: knowledge is understood to be a social construction and the values centre on social justice. Knowledge and values are both related to development: knowledge evolves and grows, and social justice is about the development of a more just and egalitarian society. This is a highly consistent and integrated position, because human-centred principles underpin

development on three levels, that of knowledge, the individual and society as a whole.

(Ernest 1991, pp.118-119)

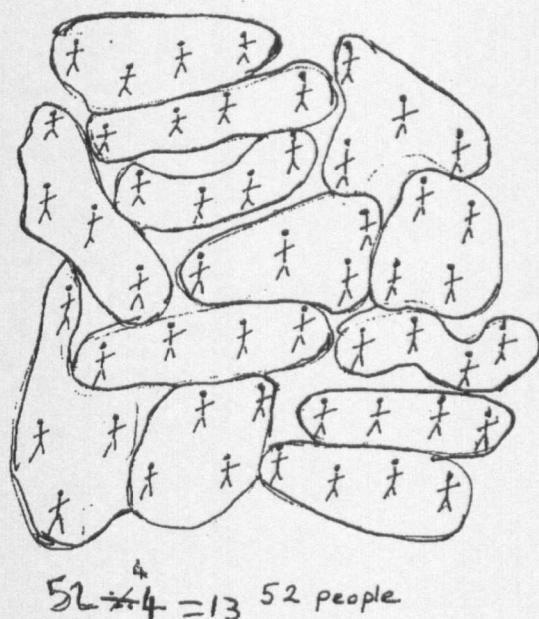
Developing and practising activities related to social justice was an integral part of the study from the beginning. My commitment to seeking social justice in mathematics education originated from my own personal and professional background (See Chapter 1, p.14). I was motivated to undertake this research through my belief that each student was entitled to equality of access in all aspects of mathematics. Relativists' judgements about mathematical knowledge depend on how individuals perceive knowledge made available to them. The students' perceptions varied and were influenced by contexts in which they were learning and expectations of adults. I observed that most people were adhering to national mathematical policies being promoted, without questioning implications for learners. Similarly, Ernest (1998, p.248) comments: "the adoption of certain rules of reasoning and consistency in mathematics mean that much of mathematics follows, without further choice or accident, by logical necessity." The idea that 'logical necessity' can guide ways within mathematics instead of sets of rules and instructions for acquiring knowledge prompted me to try different approaches with students.

Mohammed and Derek, in their respective schools, used audiotapes for accessing questions about pie charts as they examined diagrams. When they needed to know about and apply division in order to split a circle into designated sectors (parts) both resorted to inventiveness that were meaningful to them but differed from more orthodox methods and from the strategy explained on the audio recording. Mohammed went back to how he had split up circles into fractions in primary school. He could think aloud because we were not in a

classroom. Derek made use of his artistic skills and quickly drew the diagram shown below (Figure 3.2), to help him solve the problem of how many taxis were required if only four of the fifty-two people could be transported in each taxi.

Figure 3.2

Derek's diagram



Their reactions to drawing and interpreting pie charts did not support the view expressed by Orton (1992, p.176) that this topic needs to be delayed until "anchoring ideas are sufficiently formed, and then drawing pie charts might help to add meaning to the understanding of angle measurement and proportion."

Ernest's (1998, p.276) reference to 'language games' was also particularly pertinent to audio reproduction and use:

"mathematics consists of language games with very entrenched rules and patterns that are very stable and enduring but always remain open to possibility of change and, in the long term, do change." Many students' feelings of insecurity were evidently reinforced through the memory and language games in which they were expected to take part. For example as directed by their teacher in one lesson they could remember to "hang the remainder" on the next figure in long division but faced with dividing amounts in other tasks or in tests, they had no meaningful way of thinking it out for themselves if they had

forgotten the rule. Some of these students, when offered the choice, were motivated by listening to the audio recordings, to acquire skills and understand concepts that in theory they had learnt but were unable to apply in practice.

The childminder devised ways to help her and Thomas understand the operation of division by constructing apparatus to accompany recordings. In all cases interest was evident. Verbal encouragement on recordings to use their own ideas as well as, or instead of, strategies suggested, apparently reduced apprehension about division which is usually introduced later than addition, subtraction or multiplication and sometimes neglected altogether. A motivating factor was logical necessity in order to understand how to divide up circles not merely remember rules.

### *Constructivism*

One of the most challenging tasks when writing scripts for the self-check recordings was the task of attempting to avoid merely expecting students to retrieve facts and replicate these. I wanted students to construct their own strategies for tackling mathematical tasks and to be given a purposeful, practical reason for communicating, orally and in writing, their interpretation of concepts that they had formed. As Glasersfeld (1989, p. 6-7) suggests what is needed is "a different conception of what it is 'to know', a conception in which the goodness of knowledge is not predicated on likeness or representation."

Several openings occurred for students to experience inventiveness. In one-to-one sessions with me there were no peers present to criticise their personal narratives. I was able to gain insight into their understandings of concepts. Making personal audio dictionaries led to comparing strategies and choosing ones most helpful to them. Ultimately, chances were created in the CHAMPE Club for them to share their

strategies with other students and discover if others found their ways of working helpful. My beliefs are in harmony with Glasersfeld's (1989, p.17) notion that:

if students are to taste something of the expert's satisfaction in a subject they cannot be expected to find it in whatever rewards they might be given for their performance but only through becoming aware of the neatness of fit they have achieved in their own conceptual construction.

I found it interesting to know that the 'subject' in Glasersfeld's (1987) original writing referred to mathematics, but in a later edition his comment had been deemed to be transferable to subjects in general. I had no direct influence over how adults shared knowledge with students apart from making explicit my own philosophy of mathematics.

Glasersfeld (1989 p. 17) suggests that two things are required "to help and guide the student in the conceptual organisation of certain areas of experience ... on the one hand an adequate idea of where the student is and, on the other, an adequate idea of the destination". Getting to know students' existing experiences and motivation to construct knowledge that was meaningful to them, without offering 'rewards', is discussed in detail in subsequent chapters. I had no definite, definable 'destination' at the outset but based on past experiences described in Chapter 1, I did have 'expectations or anticipations' as Popper predicts (1972, p.258). Popper poses the question, that "if we have only a vague idea of what our problem consists of. How, then, can we produce an adequate solution?" (ibid, p.260). He describes the growth of knowledge in terms of trying "to solve our problems, and to obtain, by process of elimination, something approaching adequacy in our tentative solutions" (p.261). This was a way that I believed was feasible for students to construct knowledge for



themselves. Popper's observation that "all problems of pure knowledge are *problems of explanation*" (Popper, 1972, p.263) was particularly relevant to mathematics and audio reproductions made by others. Listening to explanations given on audio recordings and asking for opinions, was an enlightening experience that led to gaining knowledge about oneself as well as others.

Individuals do construct their own conception of reality and knowledge if given opportunity and appropriate input when assistance is required. I was not only interested in how participants were constructing knowledge but also social factors that could affect learning. Communication between individuals was a crucial component in situations into which I introduced the audio process. Which knowledge and skills were offered to students and ways in which these were shared in schools raised pedagogical issues. In the following section I discuss the aims of mathematical education that include cultural considerations.

## **Mathematics education**

### *Aims in practice*

In chapter 1, I stated my beliefs concerning the general aims of education. Throughout this study, I searched for and applied means that I hoped might help students develop positive, constructive, critical feelings and attitudes towards mathematics. I concur with Ernest (1991) that:

the aims of mathematics education ... represent one component of the general aims of education, combining with others to give the overall aims. Consequently the aims of mathematics education must be consistent with the general aims of education.

(Ernest 1991, p.124)

I maintain that all students are entitled to acquire relevant knowledge and should not be disadvantaged through difficulties in accessing this when it is presented in print. I was interested in bringing out "the human face of mathematics". In this respect I was like Pimm (1987, p. xvii) who cites "*communication as one of the central concerns of anyone interested in mathematics education. Mathematics is, among other things, a social activity, deeply concerned with communication*". Participants' feelings about mathematics seemed to depend, mainly, on how they perceived others rated their ability in this curricular subject. As Mercer (1995, p.1) concludes, "knowledge exists in the thought of individual people ... we are uniquely equipped to pool our mental resources and solve problems to create knowledge – through joint mental effort." Students were constantly reminded of the importance of academic achievement in this core curriculum subject, consequently the fact that they were placed in a low mathematics group set them apart socially. There was little chance of them having sufficient confidence to contribute their thoughts to joint problem solving with these feelings of inadequacy.

Results of research in secondary schools reported by Boaler, William and Brown(2000 pp.642-643) support findings in my study:

students interviewed from our setted schools create an image of setted mathematics lessons that reflects disaffection and polarisation ... students are constructed as successes or failures by the set in which they are placed as well as the extent to which they conform to the expectations the teachers have of their set.

Providing a means for accessing mathematical knowledge took me into the realms of investigating the complexities of gaining

knowledge. Watson and Mason (1998, p.37) write about "different kinds of knowing". They come to the conclusion that what really matters is, "knowing-to use this or that technique, this or that way of thinking, this or that approach, in a given situation as and when it arises" (ibid, p.37). My aspiration was that the audio process would provide a complementary means of enabling students to experience this desirable form of learning. Learning as the study proceeded involved acquiring the art of producing and using audio materials as well as becoming adept in the field of mathematics. Students helped each other practically as well as verbally. They required sufficient time to become familiar with all processes to the extent that they were able to put newly learnt skills into practice with confidence.

Findings from data analysis in this study endorse the views of Leach and Moon (1999, p.271) that:

learning rarely, if ever, occurs in the way that curriculum planners, including teachers anticipate ... opportunities to try again, to come at something from a different angle, to verbalize a lack of understanding are part and parcel of the way all adults approach informal learning later in life.

I wanted to offer a similar opportunity to students so that they felt sufficiently confident to tell others if they did not understand mathematical concepts, strategies or information and could take the initiative to apply their own ideas. Hierbert et al (1999, p.167) reinforce this view that applies to students as well as adults: "Having a different place to stand is a wonderful thing." The audio recordings were intended to offer students opportunity to try again using a different approach, if they had not understood concepts, which were assumed to be securely in their minds. Learning that took place was not limited to mathematics.

Jaworski (1994, p.17) discusses the foregone conclusion that 'the teacher' always knows 'it'. The example she gives concerns Pythagoras, but also applies to other topics. The assumption is that through teaching the students 'will know it'.

if the student's *it* seems in any substantial way to differ from the teacher's *it*, then the teaching is regarded as less than successful. To have reached the age of fourteen and still not *understand it*, does raise the question; is either the teacher's or the curriculum demands absolutist or is '*it*' a combination of both.

(Jaworksi 1994, p.18)

It was this mismatch between a student's interpretation of knowledge being shared and the interpretation intended by the person communicating the knowledge that caused difficulties for both learner and teacher. Listening, like reading, does not ensure that knowledge is comprehended and internalised. Learning is an essentially social process. Jaworski (1991, p.14) claims that "what we each *know* is the accumulation of our experiences so far". The first challenge was to find out whether students understood knowledge previously shared with them. The ongoing task was to offer students experiences in mathematics in which they were able to not only extend and apply existing knowledge but also share and create knowledge through working with others.

Lave (1988), Mercer (1995) and Bruner (1996) are among many writers who refer to knowledge as a tool for learning mathematics. It became evident during this study that it depended into whose hands tools were placed. If the individual who possessed the knowledge was unable to communicate meaning to students then the 'tool', in the form of knowledge, merely created confusion. When this happened, there was a danger of

students' feelings of self-doubt and fears of failing associated with mathematics being reinforced.

Mathematicians and educators acknowledge the multi-faceted nature and uniqueness of the field of mathematical education. Kiernan (1998 p. 223) quotes the statement made by Hierbert that "we do not yet have theories in mathematics education that unify the field and generate specific hypotheses". Having no consensus about mathematical education can be problematic for people trying to decide on acceptable aims in any aspect of life, as Bruner (1990, p.30) comments, "all one can hope for is a viable pluralism backed by a willingness to negotiate differences in world-view". The approaches put into practice were not limited to acquisition of knowledge

With the implementation of the NNS difficulties arose for introducing an innovative way of learning into classrooms. Although In-service Educational Training for staff was arranged, adults in schools often interpreted, prescriptively, the guidelines contained in this document. The time allowed to cover topics left little opportunity or inclination for adults to concentrate on less measurable activities such as creativity and enjoyment. In lessons designed for preparation for imminent national tests, the emphasis was on speed and right answers but in the more relaxed setting of the CHAMPE Club social aspects of learning could still prevail. Students were encouraged to talk about their achievements in other areas of education as well as expressing feelings of fear or apprehension they may be experiencing in mathematics.

Students who were suggested as probable beneficiaries of using audio materials had, generally, not attained levels in school or national tests that were judged by schools to be acceptable for their age group. They lacked confidence and were too unsure of themselves to be critical. Firstly they needed a reason to be critical. Pimm (1992, p.69) discusses the idea of "reporting

back" and identifies a key question as "who benefits (if anyone) and why". He points out "potential justifications" for pupil(s) doing the reporting:

for them plausible justifications include development of a range of communication skills, their use of language and development of social confidence. A further important possibility is that of developing skill at reflection on mathematical experience and distilling it into a form whereby they as well as others may learn from it.

I knew that staff, as well as students, were suffering from a surfeit of external criticism. Having been on the receiving end many times in the past, I was aware of and respected views held by the majority of adults that all outsiders, especially researchers, come into schools to put things right. In this study I was dedicated to improving inclusiveness for students by enabling better access to information but I had gained the impression that adults in schools shared this aim. I hoped that everyone would recognise the value of collaborative reflection and action and that these would become recognised activities in all situations.

### ***Cultural Considerations***

*Ethno mathematics* stands for distinct modes of explaining and coping with reality in different cultural and environmental settings ... I have coined the word 'ethnomathematics' to mean the arts or techniques developed by different cultures to explain, to understand, to cope with their environments.

(D'Ambrosio 1994, p.232-234)

Thoughts and actions were influenced by cultural considerations that included societal standards and assumptions. Students,

like Mohammed, frequently found the language of mathematics difficult to understand, because English was his additional language. Experiences in mathematics and ability to adjust to working in a variety of classrooms were inevitably determined to an extent by individuals' differing cultural and linguistic backgrounds.

The cultural views that determined who was offered opportunity to use audio materials in classrooms included assumptions made that students with visual impairment or poor literacy skills could not be expected to achieve academically in mathematics. From previous experience I knew that this could be a dangerous and erroneous assumption that could limit an individual's future, not only in the subject but also in career choices. Winter (1992) comments on how experiences in mathematics can be affected by the traditional culture of mathematics that is still evident in schools:

the problem with mathematics (and the reason for the anxieties of 'mathophobia') is a problem of mathematics as a cultural form - a combination of mystery and power: maths educators are still haunted ... by the repressive basis of the tradition they are trying to liberalize.

(Winter 1992 p.81)

It appeared to be an endless cycle. Mathematical experiences of many participants had been adversely affected by the way that knowledge and skills had been fed to them. They resorted to the same techniques when placed in position of givers instead of receivers. Stephen, Teresa and A Level Students were among the young people who demonstrated this tendency when they assisted other students in the CHAMPE Club. They were inclined to feed facts and answers immediately to listeners.

Burton (1994) criticises the National Curriculum stating that:

such a syllabus view of mathematics is inefficient to learning, as it mystifies many learners with its limitations in terms of *their* experience and understanding. When mystification makes mathematics inaccessible entitlement to its *power is denied*.

(Burton 1994, p.127)

## Using recordings for teaching, learning and understanding

The extension of the audio process to use of self-checking recordings through the CHAMPE project offered a way of learning that was not reliant on a syllabus imposed by an impersonal, external organisation. Students had a chance to choose their own starting points and strategies. Findings from analysis of data collected in the first four schools indicated that some problems had been caused by the ways in which I had introduced the idea and use of the audio process. In the following section I explain how I undertook this task.

### Distinction between teaching and telling

Pimm and Johnston-Wilder (1999, p.56) ask "What does it mean to teach?" They discuss "the complex interrelation between teaching and telling, teaching and asking, teaching and listening." Recognising the distinction between teaching and telling was essential when writing scripts for self-check recordings that included strategies for answering questions. Mason (1991, p.64) reinforces the opinion that it is not enough just to present facts and answers, "convincing people *why* something must be a fact is as important as finding out what the fact is." This reasoning influenced the decision to give answers on audio recordings after strategies for working out solutions were explained, with suggestions to pause the recording and take action at moments of decision, before



listening again. This was a deliberate ploy to involve students in taking an active part in thinking about possible strategies instead of immediately giving answers or telling them what to do. It was essential to heed the words of warning cited by Hiebert et al (1999, p.59): "in Dewey's time, as in ours, teachers more often erred on the side of providing too much information with too prescriptive a tone." Although I was not in a conventional teacher-student relationship I was aware that my voice was dominant on recordings made for use in lessons. The formation of the CHAMPE Narrating Service counteracted this voice dominance on the self-check recordings but teachers seldom gave me print copy for lessons a week in advance as requested. Two days' notice to make recordings was not enough time to request help from volunteers of the CHAMPE Narrating Service.

When the format of lessons changed in response to recommendations in the NNS, everyone was expected to tackle the same tasks within a stipulated time. The imposed change in style of teaching is an example of how teachers are expected to conform, immediately, to new policies regardless of the conditions under which they are working, their own beliefs about mathematics education or their knowledge about their students. It does not seem surprising that uncertainty exists about how to teach. During the first six months Derek thrived on using audio recordings to follow an individual programme like his peers. The difficulty occurred when he had to find, quickly, a question or example in a different section of the book when whole class teaching became the norm. Scanning for tones on recordings was far slower than visually scanning text.

I wondered whether, given the present guidelines for mathematics education, teachers stood any chance of being able to offer all students opportunity to learn in a way that was most appropriate for them. The difficulty if they took over

responsibility for producing audio recordings would be spending a disproportionate amount of time for a few individuals and consequently decreasing planning time for the whole class. I understood this dilemma and therefore concentrated on training supporters. I was uncertain of the real reasons why the majority of teachers were not encouraging students to use recordings in lessons or attend CHAMPE sessions.

## **Communicating mathematics**

A mathematical term that caused considerable confusion for listeners and producers of audio recordings was the word 'difference' when related to subtraction. When recording mathematics into language for listening there was opportunity to reinforce explanations that students may have already been told but may not have made sense of at the time, or may not have heard in a noisy classroom. They could rewind and listen again. Individual variations in use and interpretation of language are described and explained in Chapter 5. Pimm (1995, p.3) acknowledges problems that can arise when communicating in mathematical terminology:

one continuing source of difficulty in learning mathematics comes from confusion of senses of words and other symbols which have particular and (often) variant meanings ... in many cases, however, confusion has to do with a word having two or more senses in different contexts, and one sense being stronger. There are also instances where the word is similar in sound or spelling to another.

## ***Listening***

Davis (1996, p.46) discusses the differences between hearing and listening, claiming that listening is "a capacity which is founded on hearing but which goes beyond hearing. It is orienting (we listen to something) and oriented (we listen for

something). Hearing, in contrast, lacks such intentionality." Stephen's hearing was good but he found it difficult to elicit facts from what he heard. He had not acquired the art of either extracting essential numerical data from story-type problems or descriptions of diagrams, as he listened, or writing down information in note form. Alternating between reading text, looking at visual displays and writing was a tiring activity for him therefore he needed these skills. Other students without visual impairment were also struggling if their literacy skills were weak. Bone (1988, p.18) defines good listening as:

an active, integrated communication skill that demands energy and know how. It is purposeful, powerful and productive. To listen effectively we must *hear* and *select* information from the speaker, *give it meaning*, *decide how we feel about it*, and *respond*.

Listening is a skill that receives little attention beyond material published specifically for hearing impaired audiences or specialists working with them. Jensen (1995, p.76) claims that we all have ear dominance but it has no connection with whether we are right or left-handed. Identifying the better ear for hearing was important and helped students to decide how to use listening devices. John placed an earphone in his better ear and left his other ear free so that he could hear the information or instructions given by adults whilst he worked independently in lessons. Identifying the better ear for hearing interested and helped many of us to understand reasons for difficulties we encountered when listening.

Pimm (1987) argues that pupils should be trained as ~~active~~ listeners. Davis (1996) reinforces this view. He describes listening as a dynamic rather than a static skill. He refers to a hearer as an isolated individual merely receiving information

whereas a listener takes a responsive part in the process. Active involvement was essential for students dependent on listening in order for them to become constructors of their own knowledge and propose ideas for improving use and production of audio materials. Hiebert et al (1999, p.161) likewise state that, "to become full participants in a community of peers doing mathematics, students must become good listeners." From my past and recent experiences I was aware of general assumptions that if individuals can see they know how to look and if they can hear they know how to listen. Findings from analysing key incidents that occurred when students used the audio process provided evidence to the contrary, concerning both these assumptions. Only a few students were naturally good listeners and even less listened responsively.

To listen responsively requires thinking critically about what is heard. I researched and applied strategies for listening, which included developing memory skills (long and short term and working memory) and extracting relevant information from what was heard. Pimm (1987, p.34) proposes the idea of "removing the possibility of visual support, and thereby altering those aspects of the environment which serve to make disembodied speech redundant." This was an approach adopted when introducing recordings to students. Initial topics for the self-check recordings had no accompanying copy in print, which meant that users were totally reliant on their listening skills. Then simple diagrams were introduced and eventually students decided whether they just listened or followed the text in print or Braille.

The conversational form of presentation on recordings with encouragement to criticise recordings and try out different strategies was intended to persuade students to think for themselves and put their own ideas into action. Alternatively if they found repetition helpful they could regulate their own

learning by rewinding and listening again any number of times. This was one process that borrowers chose to use with the self-check recordings. Some were able to repeat recordings almost word for word but it was clear that although this demonstrated that they had memorised recordings, it gave little indication of whether they had understood what they had heard.

Another factor that affected ability to listen was background noise. This was distracting for students in lessons unless they used headphones that closed out all noise but this solution isolated them, socially. Floyd (1981, p. 263) draws attention to the intrusiveness of noise stating that there is, "the necessity to decide on a reasonable level. When noise is out of control in a classroom, it can militate against any form of innovation." Too much background noise in some mainstream classrooms did adversely affect students using audio recordings. Attempting to lower the volume of noise in classrooms was a delicate task, as I did not want to be drawn in to discussions on discipline. I was in a classroom by courtesy of the teacher in charge. How differing environments affected inclusion is described in Chapter 4.

## **Making sense of mathematics**

Pimm and Love (1991, p. vii) claim that "not knowing mathematics leaves people at the mercy of those who do understand". To understand, listening must be accompanied by comprehension. Pimm (1995) addresses two key issues, 'understanding' and 'meaning'.

understanding can arise from the creative use of language (particularly metaphor), and from images offering sudden illumination. Meaning seems, in part at least, to be more concerned with reference, hence more specific, more local; understanding seems less

concerned with such peculiarities. Yet meaning can also come about from associations and connections.

(Pimm 1995, p.3)

These two observations draw attention to the other core issue in communication. Selection of language when writing scripts was vitally important for understanding to be a possible outcome of learning. I encountered the controversy about what is meant by understanding early in my research. Professionals expressed doubts about introducing audio-recorded mathematics to students. I was asked what evidence could be submitted to claim that use of an audio medium either assisted or resulted in improving students' understanding. The audio process itself provided a way of answering this question. In order to script and explain strategies when making revision tapes or recordings it was necessary to put thoughts into words and this gave an indication of whether students understood topics. Another way of finding out if students had understood topics as they listened was to talk informally with them about content and presentation on the recording a few days later and ask them to suggest improvements.

Hiebert (1998, p.141) likens doing research to children learning mathematics in that "both researchers and children are sense makers":

we understand something when we can identify the important elements in a situation and describe the relationships between them. This definition is appropriate when learning and teaching mathematics (Hiebert and Carpenter 1992), is also appropriate when doing research. That is because doing research and learning mathematics are both best viewed as sense-making activities.

I would qualify this claim with the requirement to make clear the conditions under which an individual is expected to make this identification and give a description. Jeremy could show that he was making sense of certain topics in writing but found verbal explanations difficult, whereas Stephen was more at ease when speaking but could not show his thinking in his written work. Stephen narrated his recordings in a friendly reassuring manner that appealed to other students. Listening to the tapes and reading the scripts produced by these two students indicated their strengths. This led to discussions about paying more attention to pace and tone of voice when making audio recordings. Perhaps conversing about mathematics should be an obligatory part of assessing mathematical understanding. Speed orientated mental tests and sheets of questions in print that could quickly be marked right or wrong were unreliable measures for finding out if individuals were making sense of mathematics.

The danger of judging understanding by levels of attainment in national tests was demonstrated when this method was used in school 3 to decide starting points for individual work programs. Mohammed's starting point, based on the level he was reported to have reached in Key Stage 2 national tests, was beyond his level of understanding. For Mohammed, this situation combined with other factors ultimately ended his chance for experiencing mathematics from a different angle through an audio process.

### *Starting points*

I was drawn into the debate about whether starting points and the form of progression should be the same for everyone and which body of knowledge all students should be expected to know. This happened due to unexpected events that changed the course of the study in the first four schools and eventually resulted in me taking responsibility as the organiser of the

CHAMPE project in school 5. I would like to have pursued Pirie's (1996, p. xv) ideal that "mathematics teaching should be, an enacting (not an enactment) for the learner, a living through, a being with mathematics", but, in reality, teaching to national tests was taking over in classrooms. Ceiling-grades were being applied much earlier. Students in secondary schools were disillusioned and resentful when they were entered for low tier tests. They knew that they were not expected to exceed a certain level. This confirmed their convictions that they were failing in mathematics. The author and publisher of the Mathematics Level by Level scheme allowed me to omit levels of work and page numbers on the self-check audio-recordings. This modification lessened the competitive element that was creeping back into mathematics but could not alter the situation in lessons. Students who attended CHAMPE were encouraged to choose different starting points and request topics that they enjoyed or interested them or which they had missed or wanted to repeat.

As the study progressed I became increasingly interested in the idea of starting from different places. The majority of adults who took part in this study appeared to agree with the opinion stated in the Cockcroft Report (Report of the Committee of Inquiry into Teaching of Mathematics in Schools 1981, p.67) that:

**mathematics is a difficult subject both to teach and learn.** One of the reasons why this is so is that mathematics is a hierarchical subject. This does not mean that there is an absolute order in which it is necessary to study the subject but that ability to proceed with new work is very often dependent on a sufficient understanding of one or two pieces of work, which have gone before.



Butterworth (1999, p.320) claims that, "there's no alternative to the stage-by-stage approach of starting with basic concepts and building more advanced ones onto them." I question the value of a way of learning mathematics that prescribes, rigidly, the range of topics and tools that are offered to different age groups. Subsequent stages were frequently delayed until learners could demonstrate to the satisfaction of their teachers that they could apply an operation or term stated as being essential by professionals regarded as experts who published textbooks and schemes of work. Orton (1992, p.3) suggests that we might "understand more about learning if we knew more about the functioning of the brain as a processor of information". Butterworth (1999) explores the cognitive approach to learning in depth in his book and papers on "The Mathematical Brain". If the same amount of attention was focused on finding ways of promoting interest and enjoyment perhaps more students' experiences in mathematics might be associated with positive memories in spite of the problems of needing to pass through all the officially recognised hoops.

The value of learning by never deviating from a set series of activities or order of topics is debatable. Like many mathematics publications, the starting topic in the Mathematics Level by Level scheme, which I used for the self-check recordings was 'Place Value'. Orton (1992, p.2) stresses the importance of children understanding of place-value. Students found it difficult to change their ways of thinking about mathematics. For example it took time and understanding for them to talk in terms of moving digits to the left when multiplying by ten. They had been told earlier in their education to add a nought and although this did not work with decimal numbers, they still tried to apply this method.

The vocabulary checklist in the NNS (2000) for years 6 and 7 highlights words that "will be less familiar or new to pupils"

but 'place value' is not highlighted. The message likely to be conveyed is that this concept is understood by the time a student enters secondary education. This did not reflect the reality that I encountered with students in this study. One of the immediate difficulties with this topic is the variety of terms. Trying to define and combine seemingly simple words like number, digit, figure, place and value and, in some books the phrase face value, was a demanding task when writing scripts. As Pimm (1987) points out confusion occurs through words that can have more than one meaning: "if a hearer is unaware of this variant usage, resulting in the everyday meaning being carried over to the mathematical setting, a number of understandable difficulties may ensue" (p.8).

I was concerned that concentrating on a specific aspect of mathematics to the exclusion of others would destroy interest and undermine confidence. If a learner comes to an impasse, no amount of repetition in an identical form can aid understanding. One way of attempting to inspire interest and add enjoyment to learning mathematics was to offer students a chance to choose topics.

## Choice

Within the CHAMPE Club I was not restricted by departmental policies or an examination syllabus and therefore I could offer students the opportunity to choose topics as well as audio equipment. The dilemma was how to offer choice and maintain a balance between too much or too little intervention. Students needed to experiment with the hardware and software to make informed choices. Intervention at the start was unavoidable. Students who tried using the audio process were evidently unused to being offered a choice in mathematics. They were accustomed to depending on instructions given by adults or stated in textbooks. Few of the fifty students who attended the Club could recall what they were learning about in lessons or

suggest topics that interested or would help them. It took time and encouragement before they began to value and enjoy the apparently new experience of choosing.

Choice between two topics was offered, then increased to three and so on until students gained enough confidence to search through recordings labelled in large print and/or Braille and find out by listening to introductions (See Appendix 5e) the type of questions they would be asked and resources required. Talking about choice of topics provoked spontaneous conversations about mathematics. Another advantage was that it provided legitimate reasons for consulting all members of the mathematics departments. I asked them about details of work in progress in lessons and topics planned that would be helpful for revision and reinforcement for students who were contributing to the research. I adopted this approach in attempts to develop a constructive, collaborative working relationship with members of staff. Offering choice of topics and audio equipment in theory was a straightforward process but in practice it raised unexpected issues related to learning.

## **Motivation and confidence**

One of the most important aims when conversing with students was to get to know why they lacked confidence and interest in learning mathematics. Selinger's (1994, p.191) experience was similar to my own, "finding out how pupils view mathematical learning can often open the door to their fears and concerns as well as revealing what it is about mathematics that motivates them". How soon true feelings were revealed depended on participants' previous experiences and the type of working relationships that developed between students and adults.

The stages of learning during which motivation appeared to be lost and confidence eroded varied. Derek received sufficient support to survive a period of loss of confidence but Mark and

Stephen were not so fortunate. Mason (1988, pp. 48-49) asks, "what is the basis of mathematical confidence?" In answering this question he suggests that it involves "being aware of the spiral of: manipulating-getting a sense of-capturing symbols-fodder for further manipulation" without pressure to rush progress and being allowed time to gradually acquire confidence. It was difficult to explain why some students were motivated to use initiative and others remained disinterested in any activity associated with mathematics. It could be worthwhile pursuing the idea proposed by Lave (1988, p.42) that "a theory of motivation" is needed to assist understanding of content and presentation of feedback from participants. I investigate in more detail in Chapter 5, how different degrees of motivation affected students' learning experiences.

## **Developments and improvements**

Further analysis was needed to identify implications for developing and improving use and production of audio-recorded materials. There was no need to contrive situations to persuade participants to adopt a reflective, critical approach. We had a common aim of making constructive changes through pooling our resources and ideas to benefit future audio listeners and producers. The production cycle had shown how action-research could work in practice.

Themes had emerged from exploring how audio materials had, been used in schools. Examples of questions that formed a framework to re-analyse key incidents and dialogues were: Which changes were necessary to enable more positive experiences associated with mathematics? How can interest and enjoyment be increased through use and production of audio materials? Have feelings about mathematics changed? Which environments are likely to be conducive for combining mathematics with an audio approach? What action could be taken to encourage students to continue to

study mathematics and convince them to follow a similar path? This section and the following two chapters describe and explain negative as well as positive findings.

## **Findings from feedback**

It was not only the knowledge that people possessed that determined whether students were offered opportunity for positive experiences in mathematics but also the way that philosophies and theories were put into practice. Describing and explaining findings exposed more needs and led to identifying additional and alternative ways for improving audio recordings. It remained an ongoing search to discover better ways of developing and implementing the audio process. Implications arising from analysis of aspects of the audio process already described are noted with illustrative examples. For example in the pilot study neither of the recorders provided for Caroline and Linda met the SSM criteria of efficacy or efficiency in classrooms with thirty students. This situation alerted me to the importance of researching alternatives before launching a large-scale project.

### *Hardware*

Eighteen months was spent with participants trying out hardware before evidence of suitability was sufficiently trustworthy to support bulk-buying sets of equipment (See Appendix 7a). It was intended that items should meet the standards and requirements of present and future users of the audio process. During the following months of fieldwork, I received no adverse comments from students about the thirty recorders purchased. All machines withstood the severe tests of portability, reliability and durability in mainstream schools. The problem of poor sound reproduction on later Sony recorders was resolved through the tie clip, external microphones. Only one recorder was lost from a classroom and none were intentionally damaged. The hardware

aspect of this study could possibly be cited as a positive outcome.

The stereo earphones were most popular but had to be sterilised for each listener to prevent spread of ear infections. Regular listeners to recordings in lessons were allocated a security marked set that was stored securely in classrooms. Students expressed definite preferences with justification for their choices of earphones and headphones. Examples were: Caroline did not want her ears covered; Derek and John chose items that were unobtrusive; Thomas preferred headphones with soft ear pads; Norma liked two earphones; Alec wanted to listen to recordings without a listening device. Ear sensitivity and difficulties in listening do not seem to be recognised as problems in education unless there is an official medical condition or disruptive behaviour in lessons prompts an investigation into the possibility that hearing impairment might be a cause. The only option for those who had difficulty using listening devices was to be withdrawn from classes or listen at home. Students who showed sufficient interest to reinforce and revise mathematical topics out of school time and attend the CHAMPE Club were given priority to borrow recorders to use at home. No better solution was suggested for allocating the limited number of machines

Several adults were apprehensive and suspicious about any form of technology. One head of a mathematics department did not admit disliking all types of technological aids but another member of staff mentioned this during an informal conversation. I was generally left to draw my own conclusions about why there was lack of interest in the audio process. Prospective participants gave legitimate reasons for favouring or distancing themselves from the process. Several volunteers withdrew their offer to narrate because of the requirement to insert tones on tapes. The whole process progressed to a point

where a CD Writer and suitable computer hardware and software items were chosen for creating a website for the CHAMPE self-checking project that could be made available on the school network to all students. I provided details of technological developments in progress for members of management and staff in schools (See Appendix 7). An example was the creation of a website with sound tracks. This information was intended to ensure continuity for students when the research study ended and I was no longer involved.

### *Improving software*

It took two years before frameworks for guiding audio reproductions of print and methods for producing self-check recordings were used consistently. There was a decrease in criticism from listeners and fewer alterations requested. Students were reassured by knowing why decisions had been made and that many others had tried out the audio process in lessons and examinations and suggested improvements. Examples of changes implemented are given in this section and in Appendix 2b.

Through observation and talking with students I realised the importance of inserting deliberate pauses in speech when narrating and not to talk continuously, as acknowledged in the literacy scheme "Pause, Prompt, and Praise" (McNaughton, Glynn and Robinson 1981). On self-check recordings it was possible to include probing questions to stimulate thinking before a listener took further action. A similar procedure was followed when obtaining feedback from users during dialogue after they had finished topics.

Some students complained about narrators repeating amounts on recordings, once as a number and then in digit form e.g. £6.73 six pounds seventy three pence, six, point, seven, three pounds. This method was based on the method employed on aircraft where numbers are given twice to avoid errors in

reading instruments. When students progressed to extracting facts and figures from complex, verbose questions, they understood and valued this format. Everyone, including publishers of mathematics schemes, agreed that narrators should be named and copyright acknowledged at the end instead of the beginning of recordings.

On self-check recordings a brief introduction of a topic was given with illustrative examples, followed by practice questions with answers and then sets of questions or exercises (See Appendix 5e). Introductory sections were shortened in response to students' requests. They wanted to know immediately if they were listening to side A or B, which topics were being explained, hear an overview of the content and know if they needed diagram sheets and apparatus such as calculators. On the first tapes recorded, three tones were inserted for the start of sections, two tones for the beginning of a question and one tone for each part. Students disliked long pauses in speech. Too many tones slowed down their working even when they set the speed control to fast. The changes made to the original tapes were to insert one tone for each question and two tones for sections. Derek was the only student who managed to listen to the mathematics tapes produced by the RNIB on which there were fewer tones for finding questions and no sound indication at the end of questions to remind listeners to pause recordings. No changes were made by the RNIB in response to feedback from us.

A number of students experienced satisfaction and enjoyment associated with mathematics through developing interest in using and producing audio recordings. If the audio process had been concerned only with reproducing the words of others, making accurate recordings and providing correct answers this may never have happened.



### *Developing listening*

Tahta and Pimm (2001, p.20) discuss which sense an individual prefers when trying to make sense of mathematics and note that, "perhaps society in general had become over-reliant on visual experience". Pimm admits to his own "over-attunedness to print" and gives his interpretation of Mason's views "suggesting that the primary sense route (or balance among them) used to make 'sense of something' might have some effect on the actual sense made" (ibid, p.21). I was aware of the significance of a multi-sensory approach from my work with Caroline and Thomas in this study and as an advisor visiting children with profound and multiple learning difficulties and visual impairment in schools. Working out the 'balance' of use of senses that suited each individual was an unforeseen but necessary task that I had not predicted would arise in mathematics education in mainstream.

Students who chose to read as they listened gained confidence in reading while others preferred an aural input only. After induction sessions they were able to make informed choices about ways of listening and devices that were most suitable, through trial and error, in the CHAMPE Club. Materials to be used in lessons were modified and adapted to take into account individual preference to follow text in print as they listened or only look at diagrams and rely on the recording for information.

Stubbs (1987, p. ix) questions the effect of "growing up with no easy access to language – for example, because a child is profoundly deaf". I researched methods of teaching through audio recordings advocated by the Royal National Institute for the Deaf and consulted Robyn Guttner and other advisory teachers. The Arrow Technique was a system designed specifically for audio reproduction on tapes for users with severe hearing impairment. Students registered, officially, as

hearing impaired tried listening to self-check recordings but decided that it was easier to listen to familiar voices and to have an adult sitting next to them. Time and funds were not available to research use of audio-recorded mathematics in the field of hearing impairment but this could be a subject for a follow-up study.

### *Extending choice*

Aspects of the audio process that appealed to most students who attended CHAMPE sessions were experimenting with the various items of audio hardware, acquiring skills to listen and reviewing recordings based on the idea of book reviews.

In theory, when students had acquired sufficient knowledge and skills concerning the audio process, they had the freedom to choose whether they wanted to continue or cease using an audio complementary medium in lessons. In reality freedom of choice depended on who was teaching the class to which they were assigned. In school 5, students were offered a free choice when the CHAMPE project was organised as an Audio Mathematics Club/Library.

I wrongly assumed that students would enthusiastically seize opportunity to choose mathematics topics. They were willing to listen to topics that, in theory, they had "already done" if they required the knowledge or skill to tackle new work. Revision was acceptable but re-doing work that carried the stigma of primary school mathematics was fiercely rejected. A parent from the local community who had helped as a volunteer in the CHAMPE Club for a year summed up the situation: "*the children need the backing of the teachers, they need to really get behind them. Children are often not sure where they are lacking and need extra help.*" I agreed with her opinion, but disappointingly this was not forthcoming, perhaps because the Club opened during the lunch break.

In the CHAMPE Club students had a greater degree of freedom to make mathematical and general choices. Only students who regularly attended progressed to questioning and deciding which knowledge they required to tackle a topic and could relate choice to learning in lessons and revision without adult involvement. Students gradually realised that choice carries responsibilities that are not always evident at the outset. They found out from firsthand experience that being asked to select from a range of options is not necessarily either straightforward or possible. Constraints on choice, limits within environments and learning that resulted for adults as well as students from use of the audio process are discussed further in Chapters 4 and 5.

## **Reflection and learning**

As an independent researcher visiting schools intermittently, I was unable to offer adequate assistance to every student unable to take opportunities offered, due to missing knowledge or underdeveloped skills. It took Derek over a year to develop a dynamic view of mathematics that had powerful consequences on his progress in the school. He gained sufficient confidence to debate different strategies in mathematics with his teachers.

Failing in mathematics was not a requirement for trying out the audio process. I never knew for certain why members of both the SEN and mathematics departments were transmitting this message when talking to students and adults about the audio recordings. My words and involvement as an outsider were not influential enough to counter this intentional or unintentional misunderstanding. It was apparent that adults in schools had reasonable grounds for refusing to take responsibility for audio reproduction. Resources were scarce, especially time, but there were some individuals who were determined to pursue a positive route through all adversity. Students, like Derek, who

worked with adults who became committed to the audio process experienced collaborative communication and action associated with mathematics but I had hoped that more would have this opportunity.

I did not claim to have achieved specific aims, outcomes, goals, targets or objectives because of the complex nature of the study. This approach forestalled assumptions that the only aim of production of audio materials was to assist students gain high academic results in tests and examinations. I kept verbal and written reports as a reminder that numerous other factors were also instrumental when students' attitudes and academic progress improved (See Appendix 4). Widening the debate to incorporate discussion issues not generally associated with mathematics broadened the scope of the study, served to inspire creative thinking and provided a reason for bringing mathematics out of isolation. It also reassured teachers that I was not intent on taking over their work.

Recordings made by students and debates with adults indicated the immense variety of interpretations of symbols and pictorial displays that are shown in print. If more were known about reasons for these differing meanings it might suggest ways of avoiding or at least understanding how misinterpretations can arise when communication depends on the mathematical language. There was no one type of knowledge or experience or way of sharing that was appropriate for all students or applicable to every context. For some students audio materials offered an appropriate form of accessing that enabled them to learn and study independently without relying always on peers or adults for assistance. For others who did not disclose particular reasons why audio materials were not acceptable I was left to come to my own conclusions. Understanding at least part of the reason why some individuals preferred not to be actively involved in the study, although strongly supporting it

verbally, depended on whether participants were willing and able to communicate their thoughts and feelings. Understanding participants' thoughts and action and learning through communication was a two-way process that forms a theme of Chapter 5.

## Further thoughts

The interdependence of theory and practice in mathematics is as important in life as it is in education. Hiebert et al (1999, p.155) comment on ideas expressed by Dewey (1929) observing that "the distinction between acquiring knowledge and applying it is inappropriate for education". The theoretical aspect of production and use of audio materials was interdependent with the practical aspect. I contend that mathematics knowledge is related to all other knowledge; it should not be acquired or used in isolation. Maybe it would help bring this subject out of seclusion if more connections between different fields of education were exploited across the curriculum. I was surprised by ways in which confidence and self-esteem as well as knowledge and skills in one area of interest in education carried over into another when given a chance. Students gained confidence to talk about and explore mathematics through having opportunity to put into action their interests and strengths, more usually linked with other subjects on the curriculum. These interests ranged from art to technology and included the ability to question and debate issues of concern. The controversial subject of transferring mathematic knowledge to other spheres of learning has been well researched by Lave (1988) and others. In this study I began to understand the significance of the reverse approach, that is still not generally accepted in secondary education. Mathematics should be a receiver not always a giver of theories, methodological principles and challenges.

Accessing mathematics through use of audio materials requires listening and linguistic skills. Students are entitled to be offered opportunities that enable them to get to know, to make sense of and to apply knowledge within and beyond mathematics. A central aim of the audio process was to empower participants to contribute constructively to their own and society's knowledge and development. The proposed way forward concerning audio-recorded materials is to share, with people in other schools and settings, knowledge and skills gained through analysing experiences in this study of: choosing hardware; writing scripts; narrating; introducing and establishing the audio process into schools and working collaboratively with all participants. There was evidently no one right way of writing and recording scripts or way of listening that was appropriate for all students. If all adults were willing to communicate and take action, collaboratively with students, I believe that students could take over responsibility for adapting and modifying ways already tried out in practice for individuals, who might benefit from accessing print through audio means. Some students, as I did, gained insight into pedagogical issues and learnt how we could combine our resources, with greater understanding.

# Chapter 4: Inclusive or exclusive learning

## Introduction

Whilst it had been my intention, in this study, to facilitate inclusion of students within mainstream curricula and contexts, findings from ongoing analysis of data collected indicated that the more usual experience in classrooms was exclusion for students, the audio process and myself. In this chapter, I focus on searching for reasons to explain this outcome alongside data evidence of the problem. I describe incidents in students' stories that affected the degree of inclusiveness (See Chapter 1, p.23) possible and how my thinking and action changed. I return to the methodological approaches and frameworks that I discussed in chapter 2 to analyse these incidents. By reflecting on the significance of findings from analysis of data collected in practical situations, I identify the main themes of communication, collaborative action and choice that emerged and issues that it became necessary to address concerning ethics, risk, control and power.

With hindsight I realise how my own ideology and previous experiences as a practitioner had influenced my original thoughts and ideas about the possible benefits of use of audio-recorded materials. At the outset, I had no conception of how introduction of the NNS into schools might affect mathematics education. It seems obvious now, that I should have expected to meet opposition, but when I started the study I was convinced and reassured by the enthusiasm about the innovation that was expressed by people in schools. Everyone agreed that students unable to easily access information presented in print were undeniably disadvantaged and that exploring a way of helping them was worth trying.

I cannot claim that findings from this retrospective analysis confirm or disconfirm whether this study can be described as successful but it did serve to highlight some characteristics that may determine if students are more likely to experience inclusive or exclusive learning. I had no pre-determined definite path mapped out for this study. I found myself undertaking fieldwork in a variety of settings outside as well as inside schools. It was inevitable that experiences for each participant varied and that personal and organisational elements affected eventual outcomes. As Checkland (1999, p.101) comments an "observer may have various motives for making his systems descriptions, and the latter will reflect the nature of his motivation". I make my purpose and motivation for observations explicit in this search for explanations about why opportunity opened for students to experience inclusive learning was, in too many instances, ultimately closed.

In order to construct holistic accounts of situations I had to open and develop lines of communication between myself and participants. In conjunction with observation I relied on views and ideas from both students and adults to enable me to get to know them and external factors that might be affecting attitudes and action in classrooms. Occasionally solutions could be generalised from one context to the next but more often different, unexpected issues arose. The main task was to keep focused on the aim of the research. The most significant change in approach was making voices heard in School 5 and taking action to work towards improving existing conditions.

I wanted to know more about characteristics that lay at the core of creating environments in which students were given opportunity to fully participate in all mathematical activities and enjoy the experience in mainstream classrooms. In chapter 5 I examine how working relationships, preferred ways of



learning, personal desires, interests and feelings changed and developed as the study progressed.

It was imperative to know the pedagogical problems that existed in schools in order to understand the unexpected resistance that I had encountered from some adults in spite of the initial enthusiasm when I suggested introducing the audio process into the school. This could not be attributed entirely to the introduction of the NNS. There were examples of environments in which students like Linda, Derek and Stephen were able to use the full potential of a complementary audio-recorded medium to enhance and extend their mathematical experiences. It appeared to depend on whether and how people in control put into practice the theory "that learners are entitled to developmentally appropriate educational experiences" (Nind 2000) and how people reacted to the unpredictable events that occurred in schools. Knowledge of the early stages of concept development in mathematics was important in order to understand difficulties being encountered by students. This appeared to be a commodity rarely possessed by adults in the two secondary schools in this study.

## **Students' experiences of inclusion and exclusion**

I knew from teaching classes of thirty students that it is a daunting task to satisfy the learning requirements of every individual in supposedly homogeneous groups. Although individuals were placed in ability sets, each student had different strengths and weakness that were not immediately obvious. The safest way forward for adults interested in furthering their careers was to follow recommendations in the NNS rather than question them. One way of coping with this situation was to resort to blaming a depersonalised system. It was surprising that these doubting adults managed to convince visitors and inspectors that they were practising advice

presented in the new Strategy. Sameness is safe, especially if it conforms to governmental educational policy. However there was no guarantee that individual students were responding as intended or that implementation of the guidelines was helping to create environments in which understanding and enjoyment of mathematics was more likely to increase. I had to rely on observation and casual comments until mutual trust was established with contributors to the research. This took varying amounts of time.

In Table 4.1 (see below) conditions in which the study was conducted and main contributors to the research are listed. The types of ability setting, resources used and main type of learning environments are shown. I was looking for patterns linking different situations. Initially I was interested in incidents that were turning points for opportunities for inclusive learning to be opened but in retrospect I decided that it was of equal, if not greater importance, to explain why in so many cases opportunity was unexpectedly closed for students.

*Table 4.1 Environmental Conditions*

STUDENT	ENVIRONMENT				
	Teacher	Support	Class ability	Main resources	Main work environment
Caroline	Mr B	Ms E	Mixed	books/wsheets	Classroom
Caroline	Student	Ms E	Mixed	SATs KS2	any room free
Linda	Ms R	Ms W	Mixed	books/wsheets	Classroom
Linda	Ms V	none	2 <sup>nd</sup> tier	books/wsheets	Classroom
Mohammed	Ms Q	Ms F	Mixed	personal prog	SEN room
Thomas	Ms X	Ms Y & U Ms H	Mixed	books/wsheets	any free room
Derek	Ms A	None	Mixed	books/wsheets	SEN room

Derek	Mr D	Audio	Set 2	personal prog	Classroom
Derek	Mr L	None	Set 2	SMP books	Classroom
Derek et al	Mr D	Audio	Set 2	SMP books	Classroom
Stephen	Mr I	Audio	Mixed	personal prog	Classroom
Stephen	Mr N	Audio	Set 2	books/wsheets	Classroom
Stephen	Ms P	Audio	Set 1	SMP Level Y	Classroom
Stephen	Mr N	Audio	Set 2	SMP books B	Classroom
Jeremiah	Mr S	None	Set 3	books/wsheets	Classroom
Matthew et al	Mr K	Audio	Set 3	SMP G booklets	Classroom
Alec et al	Mr J	Audio	Set 3	books/wsheets	Classroom

The chronological summary of the situations described and explained in this chapter are intended to show how opportunities for inclusive learning were opened for students and how a variety of methodological approaches and frameworks were employed in response to the ethos and culture in the different environments and people in control. I describe reactions of participants working in these situations and how these influenced whether the outcome was greater inclusion or greater exclusion and if conditions for them were improved. Explanations for what happened based on analysing data with the benefit of hindsight, enabled me to put observations and incidents into context through knowing what preceded and followed particular events and dialogue in order to judge their relevance to the aim of the study. I was able to take an holistic view of the three years of fieldwork. (See Appendix 1 for personal details about main contributors and CHAMPE).

Seemingly favourable conditions for inclusive learning did not always result in experiences that were desirable or feasible for each individual. I give brief factual information on the impact of personal and external factors which proved to be significant to the path that students followed in the study.

## Caroline

Caroline's involvement in the pilot study provided insight into aspects of communication that I had not considered. There was no spare money at home for special resources such as a tape recorder or time for help and interest in what Caroline was doing in school except when crises occurred. Home contact was minimal. The newly appointed Head was anxious that the Ofsted inspection due the following term did not confirm the previous report that the school was failing. I arranged meetings with the mathematics coordinator but she was overwhelmed by demands to establish working procedures in line with government's recommendations ready for the impending inspection.

Communication and collaborative working with management and teachers was severely restricted due to external demands.

Caroline's teacher, Mr B, was interested in technology as well as mathematics and his enthusiasm and sense of humour made the lessons fun and enjoyable for the students. He was fully occupied preparing the class for Key Stage 2 national tests to be taken later in the term. Meetings with me were frequently cancelled due to more pressing concerns. I communicated, mainly, with Ms E, Caroline's SA. The situation altered when a young trainee teacher took over the class after half term. I had not been told about this arrangement. This was her first teaching practice. She was interested in the audio process but had not been forewarned about my presence or the introduction of use of audiotapes in the classroom. Her supervisor attended lessons frequently. Caroline could not hear instructions or explanations of topics due to the high level of noise. The advantages of not having to alternate between reading Braille and exploring diagrams by touch and being able to shut out background noise was outweighed by her concern about being socially isolated in the classroom when she wore headphones. The Head decided that there were too many adults in the room.

The only option was to withdraw Caroline from the classroom and follow the same scheme of work using audio materials. Ms E worked with us and was enthusiastic about the audio process. I organised induction training sessions for her when Caroline was absent and during lunch times when she requested. I took over her support role, occasionally, to enable her to produce Braille for other subjects. Caroline reacted to my presence and use of audio materials by passively accepting the new regime imposed on her. She seldom spoke which was out of character for an articulate student who enjoyed socialising and who was an extrovert in the playground and in most other subjects.

Looking back on Caroline's negative experiences as a result of introducing audio materials I realised aspects of inclusive learning that I had taken for granted when I was preparing to run a pilot study. I was a familiar visitor to this school but I had overlooked the need to ask about planned events in school during the summer term. I did not anticipate the communication difficulties that arose or Caroline's strong feelings about being socially excluded if she used listening devices. I used exclusion from the classroom in this case to gain understanding of how an audio medium could be a crucial component of a multi-sensory approach. This was my first insight into how listening was not the same as hearing (See Chapter 3, p.198). Feedback from induction sessions with the SA helped me to prepare similar training for narrators later on. The appreciation expressed by the mathematics co-ordinator and SA for my assistance in preparing test papers in Braille and audio conveyed the importance of giving as well as receiving help in establishing working relationships (Delamont 1992).

### *Themes and issues*

Exclusion was unavoidable in School 1 mainly due to poor communication prior to introducing the study into the school. There had been too little time to build up a rich picture of

what had happened therefore reasons to explain outcomes were incomplete and mainly based on my interpretations. The positive aspect of this situation was that, Caroline and her SA felt able to voice their views openly and as a result I gained greater understanding of how assumptions made based on previous cases of inclusive learning can be erroneous. I had also been able to assess which audio items and style of audio production might be advantageous for a student like Caroline, who had lost sight at an early age and for adults working with her.

## **Linda**

Linda's parents took an interest in the work she was doing in school. They were anxious that she should continue to attend a mainstream school like her brother. Their prime concern was that Linda should not be seen to be special or different when she transferred to secondary school at the end of the academic year. The headteacher strongly supported the audio process and foresaw its potential for other students in the school but he was retiring at the end of the term. I re-analysed data, by using the SSM mnemonic CATWOE (see Chapter 2, p.54) in attempts to explain reasons why when Linda was in one classroom inclusive learning was possible but, in another, opportunity for this type of learning was not offered.

With Ms R's cooperation, I had been able to obtain copyright permission from Heinemann publishers and produced the first series of tapes ready for use in the first lessons of the summer term 1998. Her agreement to all students listening to a recording at the beginning of the term meant that they knew the kind of information that Linda was listening to and why she had been asked to help with the research. In the classroom there was firm but fair control of behaviour including constant reminders about noise level. This meant that Linda could rely on hearing to compensate for her sight loss when topics were introduced. Ms R agreed to Linda and Ms W working out of the

classroom when I anticipated that the audio skills training required might disturb the rest of the class. We made decisions together bearing in mind that Linda was intended to be one of the main beneficiaries in this study. Ms R took into account the social side of mathematics, she tended towards a relativistic fallibilism (see chapter 3, p.182) approach when interacting with students.

Ms R expected Linda to conform to the same procedures as other students and took full responsibility for her general and academic progress. She welcomed me as an asset in lessons. We exchanged knowledge and opinions about mathematical terminology and strategies proposed in the draft of the National Numeracy Project that was still at the piloting stage. She encouraged other students to discuss their work with me and get to know more about the purpose of the research. Like Linda I was naturally included in the classroom.

Ms W took her support duties seriously. She sat next to Linda throughout lessons and worked with her even when students had been set work to complete independently. Linda was not expected to work without this input from an adult. Ms R encouraged and praised Linda, as she did with other students, when they spoke voluntarily during whole class discussions in lessons but Ms W would generally prompt Linda to speak. Before the end of term classes were re-grouped into ability sets ready for year 6. Ms V, Linda's new teacher was particularly interested in literacy. She admitted feeling apprehensive about teaching mathematics and did not want the audio system or my presence in her classroom. Ms W had been forced to stop work due to ill health. There had never been contingency plans to cover her work if she was absent. The combination of changes in conditions within the school and the VI service, plus parental concerns about Linda's future education resulted in an abrupt end to my visits to the school and no further opportunity for Linda to continue using

audio materials in order to make an informed choice about its value to her. I was not given a chance to hear Linda's interpretation of what happened.

The most significant events that ultimately led to experiences of exclusion instead of inclusion in mathematics in school 2 were the sudden retirement of Linda's SA, a change of subject teacher and appointment of a new headteacher. Maybe if Linda had been encouraged to work without constant adult input before this became a necessity she would have had a means to access, independently, mathematical information presented in print. My thoughts about Ms W's reason for sitting next to Linda in lessons changed when she told me that she only had hearing in one ear. I found it difficult to hear Linda in the classroom even though background noise was low. I had assumed that either Ms W wanted to show that she was indispensable or was apprehensive about mathematics. Use of the audio process as a contingency measure in a case of adult absence was highlighted by the crisis that occurred when Ms W had to suddenly stopped working due to ill health. If inclusiveness as interpreted by Ms R had been a general policy practiced throughout the school this may not have caused a crisis.

### ***Themes and issues***

The incident of misinterpretation of Ms W/s reason for sitting next to Linda alerted me to follow advice to consciously search to disconfirm my own as well others' interpretations of what was happening in reality and not presume that explanations were either correct or the only ones possible.

In lessons teachers controlled the amount and quality of inclusiveness possible. This raised questions about how power (See Chapter 2 p.59) was being exercised in classrooms and in decision-making concerning whether Linda continued to use the audio materials. Ms R had collaborated with me, Linda, Ms W,



and the headteacher. Linda's new teacher, Ms V, was not interested in letting students try out the audio process in her classroom. The few weeks spent in two very different environments gave me insight into how transferring from one teacher to another can be as traumatic for a student as moving to another school. Any change of environment needs to take into account continuity and knowledge of conditions and pedagogy that precede and follow moves of this nature. The whole situation requires careful monitoring by adults who take over responsibility from previous members of staff. Students' views need to be sought and taken into consideration in future planning. There was insufficient time to complete Rich Pictures in school 2. This influenced my decision to involve only one student at the beginning of the main study and not to set a rigid time limit. In both schools I had found it impossible to obtain 'thick descriptions' of reality whilst giving complete concentration to one student in a classroom. My awareness of the dangers of making assumptions was heightened by my misinterpretation of the reason why Ms W always sat next to Linda. My understanding of the disadvantage for a student who is excluded from a classroom was extended through sharing Caroline's experience. For Linda the sudden departure of Ms W was a factor in the cessation of her use of the audio process. I hoped that it was Linda's opinion that had been most influential in the decision that she would stop using audio recordings but, due to changes of circumstances in the school, I never knew.

## **Mohammed**

This was the beginning of the main study and the first time that I was concentrating on the research study without the responsibility of running the LEA VI Service. As noted in Chapter 2 Part 2, the Head of the VI Service in this North London Borough had insisted on undertaking all negotiations

with the headteacher, whom I did not meet until four weeks after the term started. Ms Q, Mohammed's maths teacher and Ms F, his IST, were enthusiastic about introducing audio materials and interested in possibilities it might have for other students. Ms Q gave each student, including Mohammed, a sequence of mathematics topics to complete, based on reports from primary schools and levels attained in the Key Stage 2 national tests. The Mathematics department had purchased The Mathematics Level by Level scheme to introduce it into the school to this Year 7.

In the classroom tables were placed close together to accommodate thirty students. Initially Mohammed sat in the front row but after a few lessons he moved to sit further back making it difficult for him to receive individual support. When a series of cover teachers supervised the class during Ms Q's frequent absences, Mohammed lost continuity in following his programme and using audio recordings to assist him. He was unable to match the speed or level of work of his fully sighted peers. It transpired that he had either never studied certain topics or had managed to cover up his confusion about the terminology associated with these. He was struggling to finish worksheets quickly to keep up with and rival his peers. He knew how his progress compared with other students because the levels and page numbers were stated at top of each worksheet. No consistent checks were carried out to find out if he had understood work that he had completed. In addition he was worried about damage to audio equipment when neither his IST nor I was in the classroom.

Mohammed became increasingly despondent and less communicative as he was handed worksheets that he could barely see. He disliked being in situations where other students could overhear what supporting adults said to him. He was striving to fit in socially, progress academically and adapt to differing

modes of discipline depending on which teacher was in charge. Noise and behaviour were often uncontrolled. The arrangement for several students to share a member of the support staff in a classroom seemed a sensible idea but Mohammed's experience illustrated drawbacks in this arrangement. Ms F was obliged to concentrate attention on another student who had been assigned to her and whose disruptive behaviour was disturbing the whole class. She was unable to provide adequate support for Mohammed in mathematics lessons.

I respected Mohammed's request not to tell his parents about the comments from his peers about extra resources and adult attention he was being given but he agreed that I could tell Ms F. The Head and staff in the mathematics department had shown no interest in the research. They had the power and influence to intervene but chose not to do so. I eventually discovered that the VI adviser had negotiated all arrangements through the SEN department. When Ms F and the VI adviser were both on long-term sick leave the only opportunity that I was offered was to withdraw Mohammed from lessons and work with him in the SEN room.

### *Themes and issues*

I had entered School 3 with the intention of working in harmony with adults as well as students. I had not anticipated taking over the role of support teacher for Mohammed or the necessity to finally withdraw him from every mathematics lesson. Changes of teachers who taught the class mathematics and incidents that could not have been predicted like a wasp invasion and false fire alarms disrupted the study from the start. Another situation that I did not know about until I started working in the school was that members of staff were feeling under threat because a follow-up Ofsted inspection was imminent. I sought solace from the postmodernism reasoning (see Chapter 2, p.91) that thoughts and questions can be provoked by failure.

Positive aspects of undertaking research in this school were: having opportunity to confront ethical issues when Mohammed needed a confidante due to peer pressure about his use of the audio process; gaining insight into how the application of mathematical language (See Chapter 2, p.171) can affect learning mathematics for a student whose first language was not English and whose sight was seriously impaired; succeeding in mustering up sufficient confidence to introduce the audio process into another school. Ultimately, participating in all mathematical activities alongside peers was not a possibility for Mohammed in this school. I was unable to establish collaborative communication relationships with adults but I experienced learning that I could take forward, from working with Mohammed during one-to-one sessions and I experienced being excluded from classrooms.

## Thomas

I had arranged to wait until after half term to begin working with Thomas to allow Mohammed to settle down in his school before I began working with Thomas. The Head spoke to me briefly and told me that she had many requests from educationalists and medical personnel wanting to work with Thomas because of his unusual eye condition. She asked me to communicate with the school through the Head of the LEA VI Service for this South London Borough. Ms X was Thomas' teacher and also the school's mathematics co-ordinator. She insisted on silence during independent work in lessons. Thomas' IST, Ms Y, or his SA, Ms U, sat next to him and wrote down the answers he dictated. I was uncertain if this was because his Braille machine was too noisy or if the teacher or VI adviser had stipulated this in supporters' job descriptions. Thomas found silence in classrooms a problem. He enjoyed social interaction with his peers but had to depend on listening to understand

what was happening around him to compensate for no sight. Without background sounds he was disadvantaged.

Thomas' parents, Ms Y and Ms U had all been willing to discuss the difficulties that Thomas was encountering in learning mathematics and his lack of enjoyment and interest in this subject. Ms Y understood the advantages of use of audiotapes to Thomas. She scripted and narrated her first recording on percentages just before she was seriously hurt in an accident. No one knew when she would be able to resume work. Ms U wanted to maintain the method that she had always used in the classroom of sitting next to Thomas. She was reluctant to acquire skills to operate the recorder or to be involved in a trial period to find out if the audio process might help Thomas to work independently. I reassured her that she would still be needed although possibly in a different capacity. She resisted all my attempts to involve her in the study and eventually obtained agreement from the Head to allow her not to take part.

Ms X left the school before the end of the term. Temporary teachers were employed to take over. I was requested by the VI adviser to stop going into the school. She agreed that I could see Thomas out of school hours in his childminder's home and persuaded the LEA to purchase a set of audio equipment.

### ***Themes and issues***

The time that I spent in School 3 gave insight into how the type of working relationships that could be formed with participants were affected by how others perceived and judged my role as a researcher and their expectations of what I should be saying and doing. I had to handle, with care and consideration to others, the ethical aspect of listening to different versions of incidents that arose when Thomas was learning mathematics, without disclosing sources. I was committed to respecting confidentiality but views about the whole situation were essential to understand the different

perceptions held and claims being made about the value of Thomas being placed in a mainstream classroom and prospects for this arrangement when he transferred to secondary school.

Thomas told his parents and the VI adviser that he wanted to continue using the audio process but I seemed to be the only adult who wanted this to happen in the classroom. Thomas attended a school that claimed to offer a model for others wanting to include a blind student in mainstream education. Adequate resources were provided but it was debatable whether these were used in the most appropriate way. Thomas was congenitally blind. His personal characteristics and background were very different from Caroline. Events affecting inclusion also differed. Audio materials might have opened an opportunity for Thomas to embark on a more independent, unsupervised way of learning mathematics in lessons if the situation in the school had been more stable and supportive. My few weeks experience in this school deterred me from asking if I could carry on with the research study in the following term. This was another example of being prepared to make a fresh start. Working with Thomas and his childminder out of the school setting was productive and enlightening concerning use and misuse of mathematical language and applying multi-sensory methods to solving problems.

## **Derek**

Inclusiveness in classrooms for Derek (see Chapter 2) varied, although I thought that I had improved my introductory explanation of the aim and implications of the research to audiences of different ages.

Derek and other students were able to experience inclusion, academic success and enjoyment in mathematics during the terms that they were in Mr D's set and attended the CHAMPE Club. My three-month absence meant that Mr D took complete

responsibility for Derek as a member of the class for the summer term 1999. Opportunity for Derek to continue benefiting from use of audio recordings in lessons was closed when he was placed in Mr L's set in September 1999. Mr L requested that Derek did not use audio items and that I should not go into the classroom until he had got to know the class and Derek had settled down in this new set. I felt this was a reasonable request. Derek did not tell me about the recurrence of his accessing difficulties and consequently his frustration in lessons, until half term when an opportunity arose for him to communicate his concerns at a CHAMPE Club session. Reasons why he chose not to do this could have been his strong desire for independence and my long absence in the summer term. Mr L had not let me know about this situation and Mr D was over burdened by demands of his new appointment as a deputy head of mathematics. This was an ethical issue. I explained to Derek why I was unable to change matters for him and he reluctantly agreed that I could talk to Mr D about the problem in his present classroom. Mr D did not tell me details of negotiations that he had to undertake so that Derek and Norma, who was also have accessing difficulties, were transferred into his set.

John, Derek's friend, had been in Mr D's set since September. Norma moved into this class at the same time as Derek. Mr D treated problems as challenges. What happened before students entered a classroom often affected how they were able to learn during a lesson. I gave another carefully prepared introductory talk. I later discovered that several class members had been absent and realise, with hindsight, that this might have one of the reasons why peer pressure was a problem later. Details of how students dealt with this challenge are given in Chapter 5. Derek and John suggested another reason for the unwelcome and provoking attention from peers was that Mr D had seated audio users as a group at the back of the room. He had assumed that this would be helpful for them and me. In response to requests

from audio users, he agreed to everyone being allowed to sit where they chose in the classroom unless their behaviour disturbed other students. I was a participant-observer, only intervening if students were doing independent work and help was required with equipment or recordings. This environment, after the peer pressure problem had been resolved, supported my interpretation of inclusive learning that revolves around the requirement for students to have opportunity and be enabled to fully participate in all mathematical activities alongside their peers. I arranged weekly meetings with Mr D to plan and review audio use in lessons, formal meetings were only arranged when any of us felt it was necessary.

The audio users worked hard in lessons and borrowed recorders and tapes to do homework. The other students followed Mr D's example and accepted the audio materials and my presence as an asset. Alice, who came to the CHAMPE Club, wanted to remain in Mr N's set because he was her form tutor. She told me that she felt unable to use audio-recordings in lessons due to comments from her peers. I planned and evaluated with Mr D in order to improve audio production to enable use of recordings when the whole class was being taught a topic. Students took SATS in May 2000 and for the first time candidates who had used audiotapes in lessons were given permission by the examining board to use this method, with the print copy, as they took the tests.

Mr D's classroom organisation took into consideration use of audio equipment and recordings and worked well even when lesson format changed to mainly whole class teaching. Derek spoke positively about use of audiotapes in the classroom, *"Mr D never saw using tapes as a problem. He saw it as a solution."* I suggested to Mr D that a lot of people feel threatened by extra demands that might be made on them by offering this opportunity of using tapes in class and asked him for his opinion. He



corroborated Derek's views about using audio materials in lessons, "No, that's been no problem at all".

### *Themes and issues*

Derek was placed in four sets with different teachers during the five terms that I worked with him. Ms A tended to favour fallibilism (see Chapter 3, p.182) but found this difficult with students who had all been assigned to the group because of behavioural problems. Mr L and a teacher who taught Mr D's set for one lesson a week adopted an absolutist approach, seemingly to maintain discipline. Mr D had gained his academic qualifications late in life but had used mathematics in his business career. He approved of inventiveness. He applied the principles of a relativistic philosophy in his classroom. He took the risk of supporting the audio process and promoting the CHAMPE project. His views on inclusiveness and its value in practice matched my own beliefs and those stated by Sailor (2002, p.13) "inclusion has to do with full membership and conjoint participation with peers at all levels". In Mr D's classroom students felt able to risk being different and follow their preferred learning styles. Derek took the greatest risk when he led the action to confront his peers, in order to ensure that individuals could continue using the audio system in lessons without harassment.

I was made aware of the politics that existed in the school through the difficulties in transferring students to different sets and founding the CHAMPE Club. The headteacher had taken the risk of allowing the research to be undertaken in the school and for the CHAMPE project to run for the two-year period required. Collaborative communication and action was possible and productive with the headteacher, Mr D, the Senior Librarian and MRO but was restricted to superficial verbal involvement with most other adults. Over fifty students took the opportunity to experience inclusiveness through the CHAMPE

Club/Library. Outcomes ranged from mathematical and personal development to students deciding that, for them, use of audio-recordings did not extend or enhance learning mathematics.

## Stephen

The headteacher of School 5 suggested that I should observe Stephen for a few lessons near the end of the Spring term 2000, before deciding if audio-recordings might be helpful for him. I also wanted to know his feelings about the prospect. During my first visits to Mr I's classroom I observed Stephen working without focusing too much attention on him. The students in this classroom were required to conform to the general rules of the school but there was little expectation or pressure on them to progress academically or do homework. They knew that they were in a bottom set and responded accordingly. Stephen was one of the few exceptions. He was working from the SMP booklets, like the others, but finding the small print text and diagrams difficult to see. Stephen's and other quieter students' abilities seemed to be underestimated judging by the topics on their individual programmes.

Mr I suggested that Alec might benefit from using the audiotapes too. Matthew took the initiative and asked if he could try working with audiotapes and with Mr I's agreement he enjoyed using them. Another student suggested by Mr I was not interested in the audio process. Students in this set were encouraged to speak freely but there was no sense of purpose or enthusiasm for gaining mathematical knowledge, applying this or acquiring new skills.

All year 8 Students were re-grouped into different sets for the Summer term. Stephen was placed in Mr N's. Mr N did not plan lessons in advance. I found it difficult to obtain print materials in time to prepare recordings ready for Stephen to use at the start of lessons. I knew from my own teaching that

insistence to keep to plans could be counter-productive for both teachers and learners but both extremes had disadvantages. On the rare occasions when Mr N told me his intended plans, he often deviated from these to the extent that audio recordings of text that I had prepared were irrelevant for Stephen. His response to how use of audio materials affected his teaching was *"if the thing is going to work without any hitches ... you not only have to plan well in advance ... the difficult part is sticking to that ... in the lesson if something is not working well you might want to ditch it and try something else ... as soon as you start not sticking to the plan it creates a problem for Stephen"*. This sounded like a sensitive way of managing the problem but in reality there generally was no initial plan. Mr N favoured a spontaneous approach but his philosophy of mathematics was orientated towards absolutism. Answers and strategies were right or wrong with little leeway allowed for diversity. After nine lessons Mr N recommended that Stephen should be moved into a top set.

Ms P took full responsibility for Stephen as a member of her class for the rest of the term. She welcomed introduction of audio materials into her classroom and suggested other students who could benefit. She asked for Stephen's ideas as well as mine about ways of incorporating use of audio materials into her teaching programmes that she prepared in advance for each on a half term. We met on Mondays to plan and evaluate how Stephen had used the audio-recordings and compare our interpretations of progress with his views. Stephen collected and returned equipment to a secure cupboard in her classroom. She included him in all activities. It seemed that Ms P was in the process of creating an environment in which Stephen and other students would be given opportunity to experience working within "a safe and secure learning environment in which pupils can expect acceptance, respect and even warmth from their teachers, without having to earn these" (Hopkins, West and

Ainscow 1996, p. 38) where "lessons are structured and well prepared" and "the opinions of pupils are key factors in the planning and organisation of what goes on in classrooms (ibid, p.42) .

Discipline was a priority in Ms P's classroom to facilitate fast accurate written work with the purpose of students attaining high levels in tests and examinations. She read out results for the class in the lesson immediately after the one in which they had taken any tests. The school kept filing cabinets full of these tests that were set after completion of topics. Publication of league tables led to academic results being a priority for schools and parents and therefore, not surprisingly, for students.

Ms P gave her opinion about teaching Stephen before students were regrouped into sets for the next academic year:

*I have asked to keep the group for next year ... he's a lovely lad, he seems to be enjoying it ... I got the impression from Mr S. that he felt this was a bit too hard for him. I said no I'm quite happy. When you've twenty in the class, who when they've grasped the concept get on like eager beavers, which they literally do, don't they ... they motor on then if you've got those two or three who need extra time, it's much better for them, I feel to be in there, than if they were in the next set down where you've got twenty who need extra help and they're going to be battling with that all the time ... as long as we're not moving along too quickly, and at the moment I don't think we are.*

Ms P was not allowed enough time by her department to pursue her interest in continuing to assist Stephen to participate fully in lessons through using audio materials. Mr S was the deputy head of mathematics responsible for assigning students

to sets. He insisted that Stephen should return to Mr N's middle band set. By this time Mr D had left the school and requests to allow Stephen to remain in his present set for a longer trial period were ignored.

At the beginning of the new academic year, audio users were placed in five classrooms that were not in close proximity to each other, instead of two as I had requested. I could not tell teachers exactly when I would be coming into their lessons, because I never knew how much support would be needed in the previous classroom. Through random visiting, I noted that the degree of inclusiveness put into practice differed when my visits were unexpected. For example audio equipment and prepared recordings were still locked in a cupboard although this was the stage in the lesson when students were required to work independently. In one classroom a key required to open a filing cabinet in which audio equipment was stored had been mislaid. In another case batteries were flat but had not been returned for re-charging. Students placed in classrooms where social and academic expectations were low tended to sit and chat with each other, which seemed to be their way of handling exclusion. After a term of attempting to support students and adults working with them in classrooms spread out in this large school, I had to admit, reluctantly, that it was an impossible task.

Stephen was not allowed to take the Key Stage 3 national tests using audiotapes and print papers with the other candidates in the Hall. I never found out the reason for this decision. I invigilated whilst he was working. The nine students, who had hoped to have the same chance as Stephen of using audio recordings for examinations, were sent to another room where members of the SEN department supervised the tests.

## *Themes and issues*

Ms P and I interpreted Stephen's reactions in lessons as indication that he was benefiting from use of the audio process. He had assured both of us that he was enjoying mathematics. It was not until he was moved out of this class that he gave me a different description of his feelings. He had not liked this quiet environment, as he was accustomed to noise at home. Jensen's (1995, p.114) observation that "forced silence and inactivity impair learners choices for input and processing" could have been the reason for Stephen's uncomplaining acceptance when was transferred back to Mr N's set. On reflection I think that the insistence on silence might explain why other individuals were not participating fully in Ms P's lessons, although their difficulties were less obvious than Stephen's. I remain uncertain about the real roots of the reasons why Stephen did not talk openly about his worries whilst he was still in Ms P's set. His mother confirmed that he was struggling with the quantity of homework. I could only surmise about alternative explanations. It could have been bravado on his part in an effort to demonstrate to all of us including his peers that he did not care and he had never wanted to be in a top set. The deputy head of mathematics, who had sufficient power to assign students to sets and make changes did not offer Stephen the choice of remaining in Ms P's set. It was disappointing that we were unable to continue to develop a collaborative working relationship that I still think could have been similar to the one that Derek experienced.

In the following sections of this chapter I look for examples that happened in practice that seemed to provide explanations for students' experiences being predominantly associated with exclusion. I refer to sources in literature to support claims that I make from retrospective analysis. I wanted to discover why introduction of an audio process intended to enable

students to fully participate in mathematics lessons alongside peers in mainstream classrooms rarely resulted in outcomes that were desirable for them or for those working with them.

## **Why exclusion?**

My interpretation of exclusion, in the context of this study, is that opportunity was, intentionally, denied to students to use audio-recorded means to complement their learning in mathematics classrooms. In the previous section, I described incidents when this occurred in practical situations for students. In this section I analyse, in greater detail, reasons to explain why promising starts in situations ended with students working out of mainstream classrooms. I begin by considering whether my involvement might have increased the likelihood that they would be withdrawn from lessons. Other aspects of the research that I consider could have contributed to students being excluded are: the roles taken by adults; inadequate resources that included support and time; misuse of power by people in influential positions; communication deficits.

### **Roles of adults**

Without my presence it would have depended on whether individual support was recommended on students' Statements or if there was enough space and support available in Learning Support areas. Students were also excluded if supporters expressed their preference to work with them on a one to one basis in a quiet environment outside the classroom. I was given reasons for this choice that ranged from Ms U's apprehension because of lack of knowledge about mathematics, to a teacher in school 5 who worked with students with dyslexia and was unwilling to allocate time to mathematics, claiming that literacy should take priority. Heads of mathematics departments generally approved of withdrawing students with special needs

giving the debatable reasons that it was more academically helpful to the students struggling to learn and less disturbing for other members of the class. The social aspect of learning seemed a secondary consideration. My preference to provide support in the classroom was regarded as unusual and was not welcomed by most teachers in secondary education, who were reluctant to have another professional in the room. I encountered resistance from eleven out of twenty adults with whom I tried to work collaboratively within classrooms.

Fullan and Hargreaves(1992, p.52) are critical of "professional isolation; of working alone, aside from one's colleagues" and offers reasons for this undesirable state of affairs that includes why they cannot allocate time to communicate with each other or outsiders:

this isolation gives teachers a certain degree of protection to exercise their discretionary judgement in the interests of the children they know best. But it also cuts teachers off from clear and meaningful feedback about the worth and effectiveness of what they do ... first teachers do not have time for collaboration ... the second consequence of high expectations and uncertainty is that collaboration becomes risky. If teachers are trapped in pursuit of their own unending aspirations, if they cannot ever do enough in their own eyes, how could they possibly meet the expectations of others?

(Fullan et al 1992, pp.52-59 )

Adults frequently cited lack of time to excuse not attending meetings arranged to plan and evaluate introduction and subsequent use of audio materials in lessons. I received apologies with feasible reasons for cancellations that were difficult to deny. The reality in schools was that day-to-day demands of managing people and events took precedence over



evaluation sessions concerning the audio process. As a teacher myself, I understood that issues of discipline, cover and impending inspections in schools must be given priority. It was when periods allocated for preparing work for students were spent in leisure pursuits such as crosswords or casual conversations that I questioned whether reaching a consensus on how planning time was prioritised was more important than timetabling additional non-contact sessions.

## Missing resources

Timing and time were significant components in the quality and frequency of the communication and collaborative action that took place between participants. Tarrini and White (1998) comment that the element of time is significant in all interactions. The time taken for self-confidence to develop was variable. It was impossible for any of the participants to overcome challenges to their beliefs and interests if they had not been allowed sufficient time or support to enable self-esteem and confidence to develop to withstand setbacks. It was not until I talked to students in the eleventh classroom that I felt that I was beginning to acquire the art of how to introduce the audio process to young people, intervene at appropriate moments and take action to avoid problems becoming crises.

A crucial area in which collaboration was lacking was skill acquisition and application to ensure that not only was a wide range of opportunities opened but also that students had the ability to utilise a complementary way of learning to its full potential. At the end of the study Mr K reflected on use of audio materials in school 5. He referred to other necessary resources that were missing. Students *"don't seem to have study skills to work on their own"* and *"they don't have an environment within the school where they can self-study except the library"*. Both these observations highlighted the contrast

between ideal theoretical conditions assumed possible and actual provision available. Attempts to overcome lack of continuity caused by frequent changes in mathematics and support staff by establishing a collaborative form of cascade skills training did not lead, as I had hoped, to sustained involvement by any other adults. Part of the aim of ongoing analysis had been to identify specific skills underdeveloped or missing.

I was interested in two environmental developments in the field of audio that drew attention to the need for statutory obligation to teach listening skills to all students. Robyn Guttner (2002) was instrumental in her London Borough in changing the title of specialists in this field to Advisory Teachers for Hearing. The term impairment was omitted to help emphasise that advice was not restricted to less able or disabled individuals. She explained how the study on Sound Fields Amplification Systems being undertaken by Professor Julie Dockrell concerning acoustics in classrooms can improve conditions for all students:

*it enhances the teacher's voice ... its good for everyone including children with English as an additional language ... the advantages are that the classes are much calmer, the teacher's voice is not so strained and the children are much more tuned into what she is saying because there isn't that strain to listen ... if they have to strain to listen they just get tired and tune out after a while ... they can relax and listen.*

(Guttner 2002, Interview)

The points Robyn makes in this description reflect findings from analysing data collected through observation in seventeen classrooms and conversations with students during and after lessons. Narrators were encouraged to speak in a way that would

interest listeners and not ask questions in strident, authoritarian tones on recordings. Improving sounds of voices and valuing feedback seemed to lower students' anxiety levels so that they could concentrate on extracting facts and figures necessary to solve mathematical problems. In occasional cases, for example when Teresa, who took over as one of the assistants in the CHAMPE Club, commented that a narrator's voice was boring, critics were asked to explain as clearly as possible the reasons for their opinion and to suggest how a recording could be improved to make it more pleasurable for listeners.

Re-examining and questioning possible explanations for why exclusion had been a more usual outcome than inclusion for students learning mathematics often revealed that ultimate decisions and action depended on people who held the power to make changes and improvements. The following section addresses this issue.

## **Power and Politics**

I analysed the use and misuse of power by applying principles of SSM and Action-research and asking the type of probing questioning employed by postmodernists (See Appendix 3b). It was essential to be aware of the type of power that was exerted, how people exercised it, where and when this happened, and individuals' reactions to people who possessed power. It was also imperative that I was able to listen non-judgementally, without being over-critical but responsively. Another pitfall to avoid was allowing my voice to always dominate in communication with others.

When the study commenced I felt that I could make a convincing case for people to contribute to the research but even if I had possessed the power I would not have chosen to exert it to insist that students continued to use audio materials after an agreed trial period. In retrospect I have concluded that maybe

I should have been more forceful communicating my concerns about the degree of inclusiveness being put into practice in mathematics education in schools. Adults readily agreed with the aim of the study but maybe I should have insisted on a trial period with them as well as with students. One positive outcome of seeing situations as they actually existed was that I gained invaluable insight into experiences of students on the receiving end of inappropriate provision.

Through observation and consultation I kept in contact with people working with students participating in the study to maintain an overview of changes and developments. The pedagogy of mathematics depended to a great extent on directives from Heads or Departments who were obliged to conform to the educational policies of the moment, but in the classroom teachers had considerable control over their own domain. Certain teachers chose to continue following traditional methods for teaching mathematics regardless of recommendations in the NNS. I faced a power dilemma. If I insisted on use of audio materials in classrooms against the will of teachers, the situation would have been intolerable for the students and myself. The alternative was to accommodate to the existing conditions that students were expected to tolerate. After problematic situations that I encountered in the first four schools I concluded that I could not influence changes for improvement if I continued to give the impression that I felt the conditions were acceptable for students. When I changed my approach and made my criticism explicit concerning inadequate provision for accessing print information in mathematics I was drawn into the complex world of school micropolitics.

I had attended INSET sessions like other adults teaching or supporting students learning mathematics but I was one of the many who had little conception of what would be entailed when the NNS was made compulsory in schools. I handled my own

uncertainty by following recommendations in this document prescriptively at first by adhering to the terms and strategies listed. I could empathise with other adults who tended to resort to the same solution. If used inflexibly, the NNS could create apprehension for teachers and learners rather than assisting them and making their work easier.

The role of adults assigned to support individual students is not usually associated with power but in some cases, their attitudes and actions related to the audio process and mathematics affected students' feelings. Ms U who constantly monitored what Thomas said or wrote seemed unaware that this heightened his anxiety about giving wrong answers. Her way of resisting the need to acquire technology skills was to claim that the audio process was unnecessary and that Thomas could obtain any information he needed through Braille or from her support. Ms Z, an SA in school 5, was more interested in acquiring computer and literacy skills than gaining knowledge about audio reproduction and use in order to help Stephen develop skills that I had already introduced to him. She supported him in mathematics after his Statement was finalised just before he took Key Stage 3 national tests. She was unconvinced about the potential value of this complementary medium in further education for a student whose sight was impaired. I was powerless to influence the situation. Her manager was the Head of the SEN department who always claimed that she and her staff were too busy with other commitments to take an active part in the research study. Mathematics education was not high on her list of priorities. Several months later Stephen dismissed the idea of trying to obtain a grade C in mathematics for GCSE, that would have given him a wider choice for tertiary education courses.

With the exception of Mr D, no member of a mathematics department in any of the five schools, took a pro-active role

in developing the audio process. People in middle management positions like heads of departments were themselves answerable to senior management. In school 5 the Head was interested in the progress of the study and the CHAMPE project. She told me in February 1999 that the school would support the research and the Millennium funded project but I never knew how this decision had been reached or who was consulted. Looking for reasons, with hindsight, I wonder if lack of communication at this point might have been a contributory factor to the resentment shown by adults to working collaboratively with me. Setting this in the larger picture of political unrest within the school that I gradually got to know about, I would not claim that any one incident or person was responsible for the complex, unpredictable pattern that the study took. I had difficulty finding out who were the main actors influencing implementation and encouraging rejection of proposed action, causes emerged much later. Students who felt that they were being forced to use audio in lessons or attend CHAMPE sessions demonstrated their creativity by providing plausible reasons for not conforming. These varied from Alice, who was in Derek's Year group, needing to go home to help her mother to Matthew, who was in Stephen's mathematics set, always giving the plausible excuse that he was in detention. Students like Derek, Norma, Stephen and Daniel who were self-motivated remained committed to the audio process, with no coercion, made invaluable contributions to its development (See Chapter 5).

## **People power**

The recurring question was how and for what reasons people sought and retained positions of power that they assumed gave them licence to choose whether they accepted or rejected innovative ideas intended to enhance students' experiences in mathematics. Some adults relied on past successes and reputations in the schools they had worked in for many years.

Their action or lack of action over time was a more accurate guide to real feelings towards research initiatives, innovations or change. Several members of mathematics departments in secondary schools in this study took active roles in unions within and outside school hours working to implement members' wishes, which did not always tally with students' interests and opinions. It was difficult to rebuff arguments and in some instances impossible to persuade them to at least give individuals a chance to try a proposed way of learning that had proved successful for other students. An example of how power was exercised that was difficult to explain arose when a network manager refused to consult anyone other than his line manager and members of senior management. This resulted in Daniel being denied opportunity to develop the website for CHAMPE and pass on skills to younger students.

Members of staff were dealing with excessive amounts of paperwork. Many were feeling threatened and uncertain about their own futures as they endeavoured to apply recommendations in the NNS. It was difficult to criticise their decisions to opt out of action and avoid confrontation at all costs to lessen stress and make day-to-day survival possible. On the one hand I began to understand possible reasons for strong resistance to an outsider suggesting yet another research initiative and visiting lessons at random. On the other hand it raised the question why all teachers did not react in this way. People like Ms R and Mr D welcomed visits any time.

Being an outsider without any means or wish to control situations seemed to present a more threatening challenge than being an insider with greater power to implement change and accompanying accountability within the school. I was not known personally in any of the London boroughs in which I undertook the main study and no organisation was financing the research. The majority of professionals were apparently worried by the

prospect of working with such a free agent. Some teachers confided that their experiences of researchers and their projects had been entirely negative and were suspicious of any ideas concerning educational research. Mr K in Derek's school summed up the situation, *"it is fair to say use of audio tapes made a significant difference to the three students I've been working with ... it has made them a lot more independent of me at times ... it has given them the basic confidence to move forwards."* Mr K had not taken a proactive role in the research. He had allowed me to visit his classroom where students were in theory using audio recordings but as I later discovered this only happened when he knew that I would be coming into a lesson. He would not agree to random visits.

The students in Mr K's bottom mathematical set were three out of ten students selected to use audiotapes for Key Stage 3 national tests but opportunity was withdrawn due to departmental, organisational problems. These students soon sensed how others viewed their achievements in mathematics although the school had tried not to make ability grouping obvious. The stigma of being associated with the Special Educational Needs or Learning Support departments or being assigned to a low ability mathematics class conveyed the message that they were inferior in some way. The reason given by one of the audio users for wanting to stop using the recordings was that *"the others think I'm thick"*. Verbal bullying is hard to detect but most of the students in this study were vulnerable to comments from peers, who they perceived to be more powerful and superior to them because they were more academically able. Mr K's words about the study were complementary, constructive and positive but I am hesitant about claiming that they accurately communicated his thoughts. He had taught in school 5 for thirty years. His comments were made during an interview, just after he had resigned from his



post. The discussion took place in the reception area where others could overhear what he said.

Conflicts arose when students were enthusiastic about the audio process but adults did not want additional equipment or any changes in their classroom or were worried by my presence. I had anticipated that people who knew their students' accessing problems would welcome an idea intended to alleviate difficulties. The study did not require funding from schools and aimed to lighten rather than increase demands on staff. The intention was that adults working with the students would also benefit but the immediate advantages for them were not obvious. It could have been that, like Mohammed's support teacher, they were already overstretched and could only think of the audio process as making more demands on them. It was Derek who put into words an advantage for adults, *"There are great demands on teachers, if you can't read, they have to come over and specially read it to you and leave everyone else, so it ain't fair, but if you have the tape thing you can do it on your own."*

I questioned why only six out of twenty adults not only survived but they and their students thrived in classrooms through using the audio process, whereas others were struggling to cope with stress and their learners were not deriving any benefit from a complementary audio medium. Adults who doubted the value of the study from the start were not looking for positive outcomes from this innovation. On reflection I think that I had neglected an aspect of the research that Derek had made explicit. I had assumed that because the process was designed to assist students this was sufficient incentive for adults to want to be involved, but evidently they needed other forms of acknowledgement in addition to my praise and thanks and seeing students benefit. Schools had been forewarned about the introduction of the NNS. It was part of the daily routine

for of members of staff to cover classes for absent colleagues. They also knew that there would be visits from officials who would be searching for faults and attributing blame without in-depth knowledge of existing situations. In this retrospective analysis I have questioned again how people reacted to these situations that could not be avoided. It seemed to depend on whether dialogue and events were interpreted as yet another insurmountable barrier to face or as a signal to reflect, re-evaluate and plan to adapt to new ways and learn from the process.

## **Use and misuse of power**

I was intrigued by the ways in which participants used their powers to direct, persuade, enlist support and convince others or use their influence to dissuade people from pursuing their interest in the innovation. I took care to vary how and when I conversed with and treated individuals when introducing this complementary form of learning. For example, talks about the process to adults differed in length and content from those I gave in classrooms. I carefully worded letters to publishers and reports submitted to the Millennium Commission. I had to persuade power holders to give their support and permission and implement action because the audio process was important and worthwhile developing (see Appendices 6b and 6e).

The headteacher in school 5 used her power positively to intervene at appropriate moments when requested and took an interest in developments proposed to improve the audio process and administration of CHAMPE until she moved to another school. I met the author and publisher of the Level by Level Mathematics scheme and they approved how their material was being audio recorded and did not restrict who could listen to the recordings or impose constraints as other publishers had done. This meant that more students could be offered opportunity to try out the audio process. The only condition

was that Daniel could not extend the website he created from the intranet to the internet without further copyright permission. Publishers held the power concerning which print copy could be audio reproduced and could stipulate who was entitled to listen to them but it was people in positions of power in LEAs and schools who decided if students were allowed to be use them.

Analysing the power aspect of situations was discussed in Chapter 2, Part 1. The level of power is generally associated with the title of the position of an individual, an obvious comparison would be a headteacher with a support assistant. A surprising finding was that in reality the supporters wielded considerable power over individuals assigned to them because they were in constant contact with the student. Their thoughts, feelings and actions strongly influenced working relationships that were formed despite their lower official status. Thomas and Stephen were two of the students whose feelings about mathematics were affected by the disaffection of their support assistants for this subject.

Three examples illustrate how people with power managed to manipulate situations. One head of mathematics praised the audio process and promised to give members of his department a copy of information that I had written explaining the purpose of the study and possible implications. I did not discover until several months later, from a mathematics teacher who was leaving the school, that the copies had not been distributed nor had the study been mentioned in departmental meetings. On another occasion, I thought that I had made a break-through when I was allowed to speak at departmental meeting arranged by a newly appointed head of mathematics. I received strong verbal support prior to the meeting. I was disconcerted when she abruptly left the room a few minutes after I started talking. No explanation was given for this sudden departure, then or

later. It was not surprising that members of staff did not offer to take an active role in promoting use of audio materials. A recently appointed LEA mathematics adviser was intent on imposing changes throughout the Borough based on her own ideas and was not interested in my research study. It would probably have been professional suicide for the new head of mathematics to disregard this adviser's directives especially with an Ofsted inspection in the following term. I was thankful that I did not have to sacrifice my vision for the future of the research to protect my career in education. In all cases I was aware that people who appeared to be listening to introductory talks, had already decided to dismiss another innovative idea without getting to know its possible value. These undermining experiences strengthened my resolve never to subject students or those working with them to similar forms of discourtesy or devaluation.

I was in a position of power in administering the CHAMPE project but only to the extent that was decided by adults with greater influence on internal organisation and policies in school 5. It was the feelings and reactions of students that inspired others and myself to develop and improve the audio process and acquire learning from the trials and tribulations along the way. I encouraged students to voice their views but my position was never intended to be permanent. I was unable to assure students that opportunities to use audio materials would continue to be available to them after the research ended. Advice given to inspectors visiting schools states that "the absence of evidence ... is not sufficient to judge things to be satisfactory" (Ofsted 2002, p.4). You cannot assume, for example, that all pupils have access to the curriculum simply because the school says that this is true. I could only hope that inspectors heeded this advice when they entered schools into which I had introduced the audio process. They needed to communicate with students as well as members of management,

teachers, supporters, MROs, Librarians and researchers, who had been instrumental in improving a complementary way of learning that students had found beneficial, supporting the claim made by Florian (1998, pp.16-17) about inclusive education "that under the right conditions, positive outcomes, though difficult to achieve, are possible for all pupils."

## Thoughts about countering exclusion

After three years of fieldwork with individuals contending with the complexity and unpredictability of life in schools today, I marvelled that there were any adults prepared to support another innovatory approach. The motivation of those who managed to incorporate another demand into their schedule mirrored my own. The incentive was the students' reactions that made the effort and time spent worthwhile. I never doubted the potential value of the process I was proposing but it was crucial to keep an open mind and be prepared to be flexible when responding to dialogue and events. Given adequate time and support when needed it seemed that students were able to judge the appropriateness of the audio process for themselves. When this was allowed to happen decisions about whether to continue or cease involvement were personal ones. Students who refused to try using the audio process were generally those who had been told before I met them, that they must take part in the study. I still cannot explain why the crucial element of choice had been underplayed or not mentioned. I do not know whether omission was intentional but I had stressed the optional nature of this research in both oral and written introductions to individuals and groups of adults as well as students.

Mohammed and several students in Derek's school experienced social exclusion from their peers as a direct result of being prime participants in the study. Providing special equipment for only a few students caused resentment from others who retaliated by marginalizing those they saw as being unfairly

privileged. This culminated in verbal and physical bullying for two students targeted. Emotions aroused affected the degree to which a student targeted could concentrate on mathematics as well as survive socially in the classroom. How feelings affected experiences is discussed in detail in Chapter 5. Hart (2000, p.131) describes how exclusion rather than inclusion can result when an innovative idea designed for just some students is introduced into a classroom, "well-intentioned additional or different provision for individuals can be exclusionary in its effects, if it diverts attention away from the search for possibilities for enhancing learning *within* what is generally provided for all." This was a real danger when the person in control of the environment was determined to keep the focus firmly on deficiencies of students. In order to enable students to fulfil their potential in mathematics and learn alongside their peers, I needed to identify which additional or complementary resources were likely to provide a means for increasing inclusiveness, and find out whether these were available to all individuals.

## **Inclusive learning**

In Chapter 3, I observed how personal ideologies associated with different mathematical philosophies influenced pedagogy in classrooms. I gave examples and explained why particular values and beliefs influenced thinking and were relevant to communicating mathematics by means of audio recordings. I examined the epistemology of mathematics and how this combined with pedagogy in schools and external elements to influence the type of opportunities opened to students. The extent to which students experienced all aspects of mathematics and were encouraged to participate in acquiring and applying skills depended on which knowledge they were offered, the way in which it was shared and whether their contributions were valued. I observed how adults behaved differently with certain students,

and in challenging situations, and in consequence affected students' feelings of self-competence as mathematicians and their enjoyment in learning. I questioned why some participants were willing and able to use the audio materials, but others were unwilling, unable or were denied opportunity.

Environments created by Ms R, Mr D and the Senior Librarian in school 5 made students and even myself as an outsider feel welcomed and respected regardless of our shortcomings and oddities. In these settings there was a chance to experience open effective communication and collaborative action. Fullan et al (1992, p.60) refer to "the power of collaborating" describing this vital activity as a "greatly under-utilized resource" for bringing about change for improvement in education. I made numerous unsuccessful attempts to collaborate with adults but professionals in LEAs and educational agencies tended to be unwilling to take risks that might cause confrontations in schools or endanger their future careers. Political and economic considerations dominated decision-making and were used as reasons for being unable to create an inclusive learning environment, even when policies were in place to make this educational aim possible. Although adults, including parents, readily pledged their support verbally, their own interests and feelings prevailed when they realised that commitment involved changing and adapting to new ways of working. Working collaboratively to improve learning situations continued to be a theme of the study and was a way of working advocated by Bruner (1996, p.68):

the cultural contexts that favour mental development are principally and inevitably interpersonal, for they involve symbolic changes and involve a variety of joint enterprises with peers, parents and teachers. Through such collaboration, the developing child gains access to the resources, the symbol

systems, and even the technology of the culture. And it is the right of every child to have equal access to these resources.

In situations where joint enterprises with others were established that included communication with parents, students were offered a chance to enjoy constructive and productive mathematical experiences. This way of working grew and developed and became the norm in some classrooms and for certain individuals extended into their personal lives; in particular it affected how Derek and Stephen related to other people outside as well as inside the classroom. It was disappointing that during the period of this research study, not many adults were willing to working collaboratively towards a common purpose of making mathematics more accessible to students by valuing their input on equal terms to their own. I came to understand the conclusion reached by Slee (1993, p.198) that "consideration needs to be given to enlisting players at all levels in the production and implementation of policy". Linda and Derek's teachers had realistically high social as well as academic expectations for them. They treated them as unique individuals in the same way as every other member in the class and respected their contributions during lessons. These students were fortunate to experience learning that challenged them but did not either over or under estimate their capabilities. Mittler (2000, p.105) in his personal reflections, comments on the importance of addressing our expectations: "I still think the main barrier to inclusive education is attitude ... the biggest handicap that people with special needs have is our underestimation of their abilities." The disadvantages and anxiety caused by setting targets and attainment levels for students as soon as they entered primary schools had not been recognised before I embarked on this research, but it soon became evident that students were



thinking of themselves as failures in mathematics much earlier in their education. Thomas in year 5 was convinced that he would never succeed in mathematics and Stephen in year 7 was thinking in terms of a future career that did not require a high attainment level in this subject.

Other factors emerged during this retrospective analysis that I would claim increased the probability that students would experience exclusion instead of inclusion as intended. Analysis of incidents soon after they had occurred often seemed to indicate failure but in the longer term they opened up different explanations and raised issues that had not been immediately obvious. One recurring query was why some students were enthusiastic about using the audio process during induction sessions but subsequently they were reluctant to use this means in the classrooms or attend the CHAMPE Club.

A parent from the local community, who regularly, voluntarily helped run CHAMPE when it was launched, suggested a possible reason why the audio process could never become a whole school affair. Her explanation, which she wrote down, was that this would not happen until parents and adults in schools were willing to get to know the scheme and take an active part in its development. Support, interest and encouragement from these adults was an essential element that was too often absent. The head of mathematics in school 5 had assured me that teachers and supporters had been given a copy of information I had written to describe and explain the purpose of the research. He apologised for being unable to allocate time for me to speak at a staff meeting. It seemed that communication between the younger and older members of the department had either never existed or had broken down.

Lack of communication initiated by adults and a distancing of themselves from direct practical involvement with audio users, reinforced students' feelings of inferiority and being

different because they were following a way of learning that suited them but was not the norm in classrooms. One intention of the study had been to assist in dispelling students' negative feelings about mathematics and themselves. In instances where support was given with interest and enthusiasm, they gained confidence and eventually came to their own conclusions about the value of the audio process and appropriateness for them.

## **Turning adversity to advantage**

A question that arose from what happened over the three year period of the study was what could have been done to prevent barriers blocking students' paths to active participation in mainstream mathematics education. I critically examined again key incidents that turned adversity into advantage for students and indicated that re-thinking was essential. I questioned how a balance was kept between focusing on participants making positive contributions and those more interested in undermining the research and when the quality of failures had proved to be more important than outcomes.

I had been worried about unscheduled visits to classrooms that I had been obliged to make when students were placed in too many different sets. This apparent adversity was turned to advantage for me but not for them. I was able to observe mismatches between what was being reported back to me and what I saw and heard happening in lessons. I found this a revealing and informative experience. I suggested to several educationalists that inspections could and should be conducted at random. I was interested in the views expressed strongly in opposition to this idea at the time and the more recent decision to give schools less notice before inspections.

I discovered that random visits to classrooms allowed me to observe if students were being enabled to actively participate

in mathematics lessons and I was able to identify factors that seemed to be causing exclusion. I learnt much from what did not happen in classrooms. One positive aspect when I was excluded from classrooms, as happened at sometime in each of the schools, was that I was able to empathise to a greater extent with students' feelings on a subjective as well as objective level. I felt frustrated, disappointed and angry and often in despair at what seemed like outright refusal to even try to improve existing conditions or allow me to go into lessons. Armstrong and Barton (1999, p.214) argue that multi-level action is required to prevent exclusion: "inclusion necessitates the removal of the material, ideological, political and economic barriers that legitimate and reproduce inequality and discrimination in the lives of disabled people." Superficial changes like re-naming rooms to which students with special needs were sent for extra help did not remove the stigma of being taken out of a classroom, or lessen the distress that students like Caroline felt about being segregated from her friends. A losing battle was in progress to change other students' low opinions about individuals extracted from lessons and sent to these special areas. This was an example of when an alternative solution to withdrawing students from lesson was urgently needed. Observing similar situations in the first four schools convinced me that I could not stand back and passively accept conditions that were promoting exclusion. I became committed to applying the principles of action research with the purpose of improving conditions for students. Learning through reflection soon after field sessions played a significant part in deciding on subsequent action to take.

A problem arose that seemed to indicate retrogression but when resolved resulted in greater understanding and insight into how events could adversely affect situations and be misinterpreted. Derek reverted to his former disruptive behaviour that none of

us could explain. It took several weeks before he felt that he was ready to disclose the reason for this sudden change. He had been told at home that he would have to leave the school at the end of term. He was worried that he would no longer have opportunity to work independently by using audio recordings but also concerned that he was being disloyal to his family. None of us had understood the importance of the audio materials to him or his sense of loyalty to people he trusted until this incident occurred. Fortunately when his mother understood the reason for his distress, she decided to delay the move until he had taken Key Stage 3 national tests.

### **Where did inclusion work and why?**

In this chapter I have endeavoured to gain greater understanding of how and why students' experiences of inclusion and exclusion varied by comparing and contrasting conditions in classrooms into which the audio process was introduced. It seems evident that ultimately it was people who determined what was possible and actually happened. Members of mathematics departments made judgements on progress and decided on action to be taken. They occasionally consulted me. In cases where a support person was assigned to a student in the classroom it seemed that audio materials were regarded as superfluous in lessons. There was a tendency for students to be withdrawn if an individual support person was available but Linda's experience indicated that this did not always happen. My findings reinforced the views of Udvar-Solner and Thousand's (1995) on the subject of support, "rarely do students need continuous ongoing supervision ... when additional support is warranted a variety of members of the school community including peers, cross-age tutors, related service personnel and classroom volunteers may serve as viable instructional agents" (ibid, pp.161-162). Unfortunately this organisation was not in place in any of the schools into which I introduced the

audio process. Use of this arrangement might have avoided overwhelming individual students with support. This was apparently also a problem in the USA, where assistants were appointed at the beginning of each school year regardless of students changing needs or preferences.

There seemed to be little common ground between classes taught as mixed ability groups and those taught in sets (see Table 4.1). Both Derek and Stephen fared better following personal programmes of work but this method did not help Mohammed.

Derek's experiences suggest conditions in which he found it easier to participate fully in lessons and personal outcomes for him were good. Findings from analysis might have presented different pictures of the classrooms in which I collected data if arrangements had been made to ensure that the classroom did "contain a variety of easily accessible resources" (Ollerton and Watson 2001, p.14). Easy accessibility to print materials was not given high priority.

Where active participation by all students was expected and provision made to enable this, adults welcomed unexpected visits as well as ones when they knew I would be in the classroom. Reflection in retrospect about roles I adopted at different stages during the research made me realise the need to always acknowledge the role I had played in situations, as well as acknowledging personal bias and ideology that might have decided on which aspects of situations I had concentrated attention during analysis. I hoped that descriptions of my involvement in incidents, combined with methodological details of how data was collected and analysed, would help readers make their own judgements about the trustworthiness of findings and enable them to make a more informed critique of how thoughts and actions might have affected ways in which participants reacted.

To end this section I look at the roles of actors who facilitated inclusion for students through both words and action. Ms E and Ms W did not complain about too much work or too little time; they made recordings at home and persevered with acquiring narrating skills. Ms R and Ms P were teachers who understood why it was necessary to supply print copy well in advance and compare interpretations of events that had occurred during lessons. They planned use of their time in school carefully to ensure that weekly evaluation meetings were always possible. Typical information given by Ms P relating to Stephen's use of audiotapes in lessons was:

*this is the plan for this half term ... because we've got these tests next week I don't want to launch into something new ... I'm going to go back over some of the rounding and then using of the estimating after they've done rounding ... the questions that we are going to use for that are ... [details given about print copy with page numbers and method proposed] it'll be a question of I'll call out names and they will round it to ... and they've got to shout them back.*

I commented that in this instance it was not necessary for Stephen to have the questions audio-recorded. We discussed enlarging print but this did not help Stephen because his eye condition caused difficulty in scanning large areas looking for questions and figures. I agreed to record certain questions so that Stephen could listen to these again at home.

This way of working enabled me to produce recordings ready for lessons and revolved around ensuring that resources and arrangements were appropriate for the student. The ideal from the perspective of inclusive learning would have been if Ms P had taken responsibility for choosing activities in which

Stephen could have engaged, when she was compiling her lesson plans.

Mr D, who was pro-active in the introduction and development of use of audio materials, agreed to present, jointly with me, a paper that I had prepared for the ISEC 2000 conference entitled, 'Audio Mathematics for Participation and Equity' (Simmons 2000). We were in agreement that only providing access would not ensure that students took a full and active part in mathematics. Outcomes were determined by many additional factors. His reply to my question concerning how useful audiotapes had been for Derek was:

*I think it has been invaluable. Without using those tapes he wouldn't have been able to access pupil books ... I've talked to his form tutor regularly and told her how well he is doing so that she can give him some praise. He enjoys the praise and thrives on that ... in registration everyone else hears it.*

The interest and encouragement that Derek received from the headteacher, Head of Year 9 and his mathematics teacher ensured that he gradually gained sufficient confidence to continue using audio recordings and surmount the barriers that at times threatened to close opportunity for him (see chapter 5).

## **Beyond mathematics**

Ideas that Bhabha (1994) includes in his writing are relevant to themes that emerged from analysing, with hindsight, data collected during this study:

beyond signifies spatial distance, marks progress, promises the future; but our intimations of exceeding the barrier or boundary - the very act of going beyond - are unknowable, unrepresentable, without a return to the 'present', which in the process of repetition, becomes disjunct and displaced ... the

boundary becomes the place from which *something begins its presencing* in a movement ... the borderline work of culture demands an encounter with 'newness' that is not part of the continuum of past and present.

(Bhabha 1994, pp.4-7)

The type of environment conducive to moving forwards and implementing improvements for students was not wholly based on pedagogy from the past but neither was present provision regarded as adequate or acceptable. All difficulties could not be attributed to traditional methods that continue to influence mathematics education today. Entitlements of members of minority groups, like students unable to easily access information through a print medium, had to be recognised and action taken to implement changes to extend, improve and enhance learning experiences.

It is necessary to apply Bhabha's words in practice, to develop a culture that is committed to creating educational environments designed to celebrate individual diversity and value alternative and complementary ways of learning. All students should be offered opportunity to actively participate in and experience enjoyment in mathematics and be enabled to acquire enough confidence and skill to move beyond the boundaries of the subject into unknown territory within the world that exists beyond the classroom and school.

Bhabha's writing is on cultural differences of race and gender but students contributing to this research also experienced discrimination through social and academic exclusion. The study originally targeted students with sight disability who were encountering difficulties in easily accessing mathematical information presented in print but by stepping over boundaries we entered new fields of learning. The study evolved as working towards an inclusive educational approach opened to all



students. It was intended to increase awareness of their desires and preferences and assist in acknowledging these in practice not only in theory.

In a written account of a conversation with Slee, Corbett (2000) explains an approach to inclusive education that has become known as connective pedagogy:

the teacher helps individuals feel included in the curriculum by firstly connecting with them and their learning style and then secondly, connecting them with the wider community of the classroom, school and local community. Without the first stage, they can remain locationally integrated but not included. Without the second stage, they can have their individual needs addressed but be excluded from wider group participation. To achieve this level of connectedness requires a sustained and responsive awareness of the potential barriers to educational inclusion.

(Corbett and Slee 2000, pp.141-142)

I attempted to identify factors that had seemed to be causing exclusion in order to understand which changes are needed to achieve a desirable state of connectedness. The wording of the original research proposal gives a misleading impression of objectivity and simplicity but it was subjectivity and complexity that were the most challenging aspects of this study that depended on people working within social settings. It was restricted to classrooms at the beginning but elements that contributed to erection of barriers to inclusions, often originated from sources outside classrooms and the field of mathematics.

## Thoughts to take forwards

Lakatos (1976, p.68) states that "one of the main points about critical rationalism is that one is always prepared to abandon one's original problem in the course of the solution and replace it by another one." Addressing the original problem of accessing mathematics took me into fields of learning way beyond the subject of mathematics. Analysing students' and my own experiences led to realisation that it was a process that I term as reciprocal learning that inspired, gave impetus and motivated us to tackle challenges that sometimes seemed overwhelming. This form of learning depended on collaborative action to ensure that the research did not become an objective, technical and static study confined to the field of mathematics.

Too few students who contributed to the research were offered opportunity to experience inclusive learning for enough time in appropriate settings, in ways most beneficial for them. I would suggest that ideas that emerged from examining environments are worth thinking about and exploring in practice. There is no certainty that what happened in this study will be replicated in different contexts, with different participants but being forewarned about some of the complexities and problems that can cause additional difficulties, might assist others in similar ventures designed to assist students and those working with them. Findings from this study should be interpreted as Slee (1993) proposed as "suggestive" rather than "conclusive and prescriptive" and action taken to ensure that all voices are heard:

the fundamental and most forgotten lesson from the project was the affirmation of the need to listen to those in the field. Some have been denied a voice particularly the disabled and their families.

Inclusive policy is recognized by the resonance of these voices at every level.

(Slee 1993, p.98)

The theme that kept recurring as I wrote this account was that it is essential to listen and take action in response to those in the field at every level. I discovered through undertaking this research in five schools that "pedagogy is now increasingly about learning from the learner" (Corbett, 2001, p.115). As the study progressed my thinking developed along similar lines to Oliver (1999):

we have been forced to recognise that we have as much, if not more to learn from others as they have from us ... we need to approach our attempts to understand the worlds to which we are moving, not just in respect of disability but of understanding every aspect of ourselves and our lives.

(Oliver 1999, p.x)

It was getting to know and understand this approach that was a major challenge. It was not enough to recognise that to move forwards I needed to learn from others as well as them learning from me. I also had to open opportunity and offer appropriate support for this to be possible. We all required the will and desire to communicate effectively with each other. The purpose was to develop a collaborative approach both to decision-making and taking action to implement decisions to make improvements. Details about how the process of reciprocal learning was established and its development affected participants' experiences are described and explained in chapter 5.

# Chapter 5: Reflective reciprocal learning

## Introduction

In this chapter I re-examine data collected over three years of fieldwork to trace how an approach evolved that provided a possible means for tapping the under-used resources of students, themselves, in mathematics education. The frameworks that I use for analysis are principles from methodologies described in Chapter 2. I do not cross-reference back to methodologies described in earlier chapters because I applied these constantly in analysing the process of reflective reciprocal learning. As Checkland et al (1990, p.58) point out *"mouldability by a particular user in a particular situation is the point of methodology. That is why a methodology is so much more powerful than mere method or technique"*. I also refer to specific questions used for ongoing analysis during practical phases from which the main themes (communication, collaboration, choice), and issues (control, ethics, risk and support and power) emerged as explained in the previous chapters. Explanations in this analytical story are supported by students' voices as well as detailed descriptions of their experiences.

In the first part of the chapter, I explain the experiences through which I came to understand that the type of relationships formed with both students and adults, at the start, affected interactions in the future and ultimately outcomes. I tackle the task of analysing how addressing issues of students accessing print, in practice, transformed my thinking, gave insight into other fields of education, for example computer technology and focused attention in the study on a process that I termed as reciprocal learning. In the second part of the chapter, I describe deliberate action that I took to open opportunities to empower students to play a more

active part in exercising control over their own learning. I identify elements that were essential to support and facilitate reciprocal learning. In Part 3 I give an account of how I applied and exploited the developing concept of reciprocal learning.

I took the risk of undertaking activities and entering into in-depth working relationships that I had not anticipated when I planned this research. I allowed my initial thoughts and ideas to be challenged and changed these in response to events and dialogue, when analysis of findings from data collected indicated that this would further the aim of the research. Themes related to reciprocal learning emerged, logically, from comparing what happened in reality with what I predicted. I realised the necessity for a two-way communication and action process that was characterised by no prior assumption of superiority of any contributor at the start. One of the aims of the funded project CHAMPE had been to enable adults as well as students to experience the value of this approach to learning. Learning was a cumulative process. Characteristics of reciprocal learning that gradually evolved are summarised on Table 5.1 (see below). I questioned, again, findings from each of the main case studies to compare and contrast contributions made and learning gained by each of us who took part in the study. Particular aspects of learning and action that informed planning for subsequent practical sessions were identified. In exploring this learning approach some of us met conditions that militated against increasing opportunities for students to experience inclusiveness in mathematics education in classrooms.

A Chronological and Methodological Overview is shown on Figure 5.1 to remind readers of the different phases and recesses through which the study passed, individuals involved and the

strong links between methodological theory and practice throughout the research.

FIGURE 5.1 CHRONOLOGICAL and METHODOLOGICAL OVERVIEW

(See Glossary for Key to acronyms on this diagram)

\*R.D. Root Definition

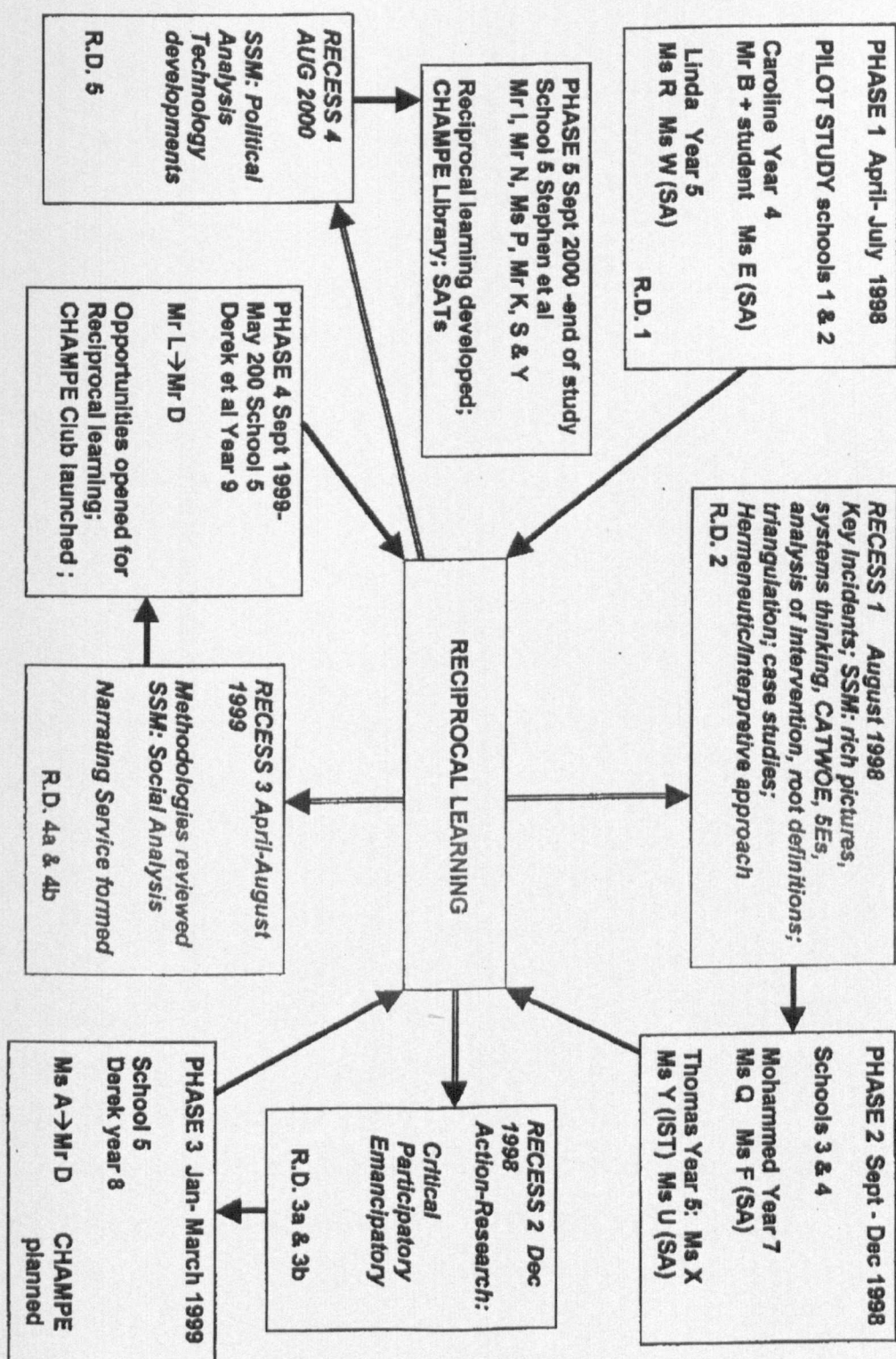


FIGURE 5.1

## Lessons about learning in the pilot study

### Caroline

In Chapter 4 I gave reasons why I had not wanted to withdraw Caroline from lessons but in the circumstances there had been no choice. If this had not happened probably none of us would have experienced the value and stimulation of a collaborative working relationship in which neither age or status affected the importance of our contribution to the task being tackled. Aspects of learning highlighted by working with Caroline are how students and adults can be affected by enabling them to: express their views; take control of personal learning; support others;

### *Effects of enabling students to express their views*

Withdrawal from mathematics lessons opened opportunities for understanding Caroline as a learner in ways not possible in the constrained atmosphere of the classroom. Always having a support assistant present affected the amount of social interaction between Caroline and other students and lessened expectation for her to be able to work independently. The advantage of Caroline, Ms E (SA), and I working together when she was withdrawn from lessons was that Caroline received immediate response from us and we gained insight into how challenging it could be to access text and diagrams by touch.

The breakthrough in communication with Caroline came towards the end of the pilot study. Caroline criticised the recorder that had been allocated to her by the LEA. She explained that the keys were too close together for her to press and Ms E agreed that she found this complex machine difficult to operate. Criticism of the recorders led to discussing listening devices. Caroline agreed with Ms E's remark that for her to wear headphones was, "like putting her in a cupboard". The



difficulty was if ear or headphones were not used in lessons the sound from recordings would disturb other students.

This experience of being encouraged to be critical and make choices to which adults were prepared to listen and respond with practical action appealed to Caroline who forgot about her reticence to speak. From this point onwards she began to talk freely. It was as if her pent up emotions had been released. As Holt (1984, p.9) warns, we should not assume that from learning about people in an unusual situation, "we can make reliable judgments about what they do in very different and usual situations." I think that it was from this incident that Caroline gradually realised that her thoughts were worth expressing and could influence what happened. She was further reassured when her mathematics teacher lent his own earphones for her to try out.

### *Taking control of personal learning*

It was combined problem solving, leading to the adoption of a multi-sensory approach, which helped Caroline understand the topic of compass points that her class was studying. The raised diagram on paper did not help her. We constructed a piece of apparatus consisting of a cork board with a movable arrow in the centre. The arrow could be turned with one hand to find directions of objects from the lighthouse, as Caroline operated my small audio recorder with her other hand. She was able to listen to the questions that I had narrated onto an audiotape as she examined the tactile diagrams that Ms E had prepared. She could concentrate on finding features on the diagram without having to move both hands from reading Braille to the diagram or depend on either of us for help.

I reassured Caroline that she would not upset anyone by choosing not to use audio materials. She chose to be with her friends studying the same topic in the classroom. I thanked her

for the invaluable contribution she had made through giving reasons for her criticism of the audio equipment and the first audio recording that I had produced. I spoke to her when I visited School 1 for the last time and she confirmed that she definitely preferred not to use audio recordings. She had enjoyed listening without being made to wear anything over or in her ears but as this would have disturbed others in the classroom she wanted to read Braille and rely on Ms E for help in lessons. I could only hope that the experience of contributing to the pilot study might be of use to her sometime in the future, if she needed an alternative to accessing text by touch, as Andrew Hart, a graduate Australian student, had found when he could not obtain mathematical materials in Braille quickly enough for his doctoral studies. This experience highlighted the importance of responding to students' voices by offering alternatives even when observation indicated that they seemed to be enjoying an activity and benefiting from it.

### *Supporting the support assistant*

Ms E and I took into account Caroline's comments and experiences when we planned materials for subsequent sessions. Ms E was enthusiastic about using the audio system as a complementary medium for learning mathematics. It was quicker for her to audio record text than to reproduce it in Braille. She had not considered using audio recordings for mathematics before she took part in this study. Her determination and ability to learn as much as possible about audio equipment and production within a few weeks was creditable.

Ms E's enthusiasm and interest in the audio process indicated that personal guidance and praise are important to adults as well as students, especially if they feel unsure about a new way of working. I asked Ms E to contact me if she wanted further advice but I was confident that she had, through her

own perseverance, acquired adequate skills to produce audio materials, if Caroline or any other student assigned to her for support, chose to use an audio-recorded medium to complement learning (See Appendix 5 for Ms E's notes on an induction session).

### *Implications for facilitating reciprocal learning*

I learned from Caroline that even if students know an adult well there is no certainty that they will feel confident enough to express their feelings openly. If Caroline had continued to resort to silence to cover up her strong feelings about use of listening devices Ms E and I would never have benefited from her illuminating commentaries as she was working. We had the opportunity to learn from her the disadvantages as well as the advantages of relying on audio-recordings. Occasional withdrawal sessions were evidently useful. If the 'lighthouse' activity had been undertaken with the existing provision in the classroom the items of equipment would have occupied a large amount of a table surface causing difficulties for other students.

As noted in earlier chapters, Caroline's feedback motivated me to explore, in greater depth, the field of audio recorders and accessories in other countries as well as the UK. Caroline had seemingly felt secure enough after a few weeks to take control of her own future by voicing her preferences. It was the type of relationship that developed between us, in spite of an inauspicious start that I found most significant. But the question for me was if this would be possible in a classroom.

### **Linda**

By getting to know abilities, interests and concerns of Linda as a learner and adults working with her, I learnt that it was essential to look for explanations for words and actions of others in order to understand reasons for their reactions and

responses to events and dialogue. Working with Linda confirmed to me the importance of encouraging students to: assume some control over their own learning; share their negative and positive experiences with others; tell adults about difficulties when circumstances change.

### *Taking control*

The implication of the unpredictable nature of Linda's visual impairment was that she had to take responsibility for constantly giving guidance to others about the form of accessing information that she found easiest. She wanted to read text but if questions were long or her sight was poor on a particular day she found it helpful to listen to audio-recordings as she was looking at print copy. She did not appear to be at ease with adults but was sociable and talkative with students out of the classroom. One way of obtaining more than yes or no answers was to converse, informally, about topics and visual displays, rather than continually ask if she could see text, lines or details on diagrams.

After one term, Linda seemed to realise that adults were taking seriously the choices and decisions that she made. She began to enjoy taking some control over how she could access the same information as her peers. I always asked for her views about audio-recordings after lessons and incorporated her ideas in recordings for the next topic. A collaborative relationship similar to the one that developed in Caroline's school might have been possible, in a classroom, if circumstances within this school and for Ms W had remained the same. Ms W felt unable to disclose her hearing difficulties until she felt able to talk openly to me. The incident that was the turning point in our relationship was when Linda confirmed that it was Ms W's observation, not mine, that explained why she had difficulty making sense of a mathematical question. It seemed that until

that moment Ms W had assumed that her views were insignificant compared with mine.

### *Sharing knowledge and experience*

In addition to talking with Linda herself, one of the most positive and productive aspects for me was exchanging information and working in the classroom with Linda's teacher, Ms R. I consulted her before lessons to check if she advised working with Linda for part of the next lesson out of the classroom if a topic was visually particularly demanding. Time had to be found for mutual consultation without depriving students of learning experiences or adults of relaxation periods in breaks during the day. Occasionally I withdrew Linda from lessons with or without Ms W, to elicit opinions about the audio materials or give additional guidance for use of audio items. Ms R was unperturbed if visitors came into the classroom because she planned lessons well in advance, taking all her students' needs into account. Adopting a flexible approach allowed arrangements to be changed in response to teaching and learning requirements keeping in mind that Linda was the main beneficiary and giving priority to her requirements, whenever possible. As noted in Chapter 4, Ms R regarded me as an asset in the classroom: she told me that discussing how to word questions to be audio recorded had clarified, for her, terminology recommended in the NNS. She encouraged others in the class to interact with me and discuss what research entailed. She also commented on the general improvement in Linda's listening and concentration skills.

### *Effects of changed circumstances*

One of the more difficult outcomes to accept was that I had not been invited to meetings convened to decide whether Linda wanted to continue using the audio process after the pilot study finished. I never knew how the final choice had been

made. Changes that occurred within the school would have daunted most students, who had only had a chance to try a different way of working for a few weeks and already had misgivings about leaving primary school. In Year 5, Linda had been given opportunity in an inclusive learning environment to try out an alternative way of working that would enable her to decrease her reliance on adults to assist her in lessons. Disappointingly in Year 6 there was not a similar sensitivity to her requirements from a mathematics teacher recently appointed. Linda's sudden loss of Ms W's support served to remind me, that there is a danger in total reliance on one individual support person, style of learning or type of media with no alternative or contingency plans considered. The individual most disadvantaged was Linda.

### *Implications for facilitating reciprocal learning*

From my observation and participation in the situations in school 2, I concluded that reciprocal learning is facilitated through relaxation. Linda and Ms W were more at ease when they were communicating with me, informally, rather than in formal interviews. I concentrated on making sure that everyone implicated in the study was given opportunity and enough support to speak as well as carefully choosing where discussions took place. Adults needed as much reassurance and time as students to express their views, show feelings and take risks. Everyone needed to understand the purpose of the study, their roles and how they could contribute. It could not be assumed that participants possessed debating and discussion skills, especially listening and sensing when and how to speak. Possible dangers of misinterpreting words and actions had been highlighted by incidents involving Ms W's hearing the SENCO's real concern and differing ideas about the difficulties that a student was encountering in accessing a mathematical problem. Working collaboratively with Ms R and listening to the

advantages of the audio process for her, as a teacher, was the first indication that the innovation could be productive for both a student and adults in a mainstream class of thirty students.

## **Lessons about reciprocal learning in Schools 3 and 4**

The main study started in September 1998. Preparation undertaken and procedures implemented throughout the study are described in Chapter 2, Parts 1 and 2. A summary is shown on Figure 5.1 (p.267).

### **Mohammed**

Mohammed wanted to succeed in education to meet his father's academic expectations for him as the eldest son of the family. As noted in Chapter 2, Part 2, I met him for the first time in his primary school. He talked openly about his hopes and fears of moving to a secondary school. He did not want to be treated differently from his peers. For example, he was insisting on struggling to use a transparent ruler like other students instead of a ruler with black tactile markings contrasted with a yellow background that the VI adviser had provided.

For Mohammed, productive learning alongside his peers in the classroom was not possible owing to a series of events that were unexpected and in most instances unavoidable (See Chapter 4). Withdrawal sessions were useful at first but by the end of one term it was segregation. There was no prospect of transferring back into the classroom. Staff absences resulted in no individual support or teacher who consistently taught Mohammed's class and advice from the VI adviser was unavailable. Collaboration was restricted to communication and action with Mohammed and his parents. Issues related to reciprocal learning that were raised in my work with Mohammed

were: how to break down barriers to learning; how to instil trust in relationships; how to open opportunities for decision-making; the importance of clarifying my roles in situations.

### *Overcoming barriers to learning through listening and responding*

One of Mohammed's strengths was remembering numbers with many digits when listening and he enjoyed trying to exceed his own record. He had a good memory and encouraging him to use and improve this boosted his confidence but did not ensure understanding. By learning from each other we decided on ways worth trying to help listeners obtain data more easily without making errors, for example, announcing whole amounts and then repeating these by dictating the digits in short series, with pauses to allow time for writing. During one-to-one sessions Mohammed began to show his frustration as he battled to understand mathematical topics that, according to his Level 5 rating in the Key Stage 2 national tests he had already learned. His teacher was not familiar with the Level by Level mathematics scheme. On one occasion when listening to an explanation on tape about finding the mean and mode of numbers his words came tumbling out:

*the guy was talking too fast ... I had no idea what the guy was talking about ... I didn't understand it properly cos he was chatting a whole load of mathematics language that I ain't even heard before, cos I wasn't taught that stuff.*

This was the topic on a worksheet that I had been told he had just finished. We talked about his agitation and laughed together about the series of extraordinary events that had made things so difficult for him. By the end of the session he had relaxed and was determined, again, to persevere with his mathematics programme. This was an important turning point. Subsequently, Mohammed showed great determination to understand



topics, not just finish questions quickly. The only exception was if he had been upset by incidents that had just preceded his arrival.

### *Establishing Trust*

Mohammed finally stopped pretending that everything was fine. This did not happen until he knew that his ideas to alter recordings were being taken seriously and changes were made. It took longer for him to understand that his thoughts and feelings were viewed as important even though he was not completing worksheets as fast as some of his peers or obtaining such high marks for his work.

At the beginning of one session out of the classroom he suddenly confided that his peers were 'jealous' of him receiving extra help and resources. In the introductory talk that I had given to his class, I emphasised that I had asked Mohammed to help me with my research for a few weeks to find out if listening to questions on audiotapes might be helpful for mathematics. Later some students asked me if they could try using the audiotapes. I explained that I did not have enough recorders but it might be possible in the future. They did not pursue the matter with me but I have since wondered whether they thought that I had not taken their requests seriously. It was soon after this conversation that a sequence of incidents occurred that undermined what had seemed to be a promising start to the main study (See Chapter 4).

Mohammed was battling to meet many challenges without sufficient support from adults with power or interest to insist on changes to enable him to carry on using audiotapes in lessons. He was attempting to establish social friendships and determined to show everyone that he could cope with all demands on him. I could only offer him the choice of borrowing a recorder and sending recordings by post for him to use for

revision and practice at home or he could return to relying on reading enlarged print that he disliked in his primary school because it slowed down his speed of work. He chose the first option. I made sure that Mohammed, his parents and other adults who had worked with him knew how valuable his input had been during the past three months.

### *Decision-making restricted*

Mohammed was not been given a choice to go on using audio materials in mathematics lessons in the school but I hoped that he would take control of his own learning and continue to make contributions to the research. It was his enthusiasm to continue using audio recordings that persuaded me to devise an individual distance-learning programme. This was a new experience for me. I was no longer visiting the school. There was an interesting outcome to this unwanted change. Mohammed needed to explain, by telephone, topics he was studying and strategies he had been taught. This required using mathematical language. It soon became evident when he did not understand a topic and mathematical terminology associated with it. By the end of the following year he had been moved to a special school, which was not what he had wanted but as I heard from the VI adviser, circumstances in the school made this unavoidable. I had been motivated to apply for funds for more audio equipment by requests from the students in Mohammed's school. It was disappointing that the funded project could not be based in School 4 as I had intended.

### *Clarifying roles*

Environmental and organisational elements differed in this large comprehensive school from the two primary schools that I used for the pilot study. With hindsight I concluded that my introductory talk to Mohammed's class did not have enough impact on students.

I became aware of complications that can arise within relationships with adults through my experiences in school 3. The following extract is from a session with the SENCO and Ms F is an example of how important it was to be clear about our roles, be prepared to change these and make our thoughts explicit. Ms F had just returned from several weeks of absence due to illness. The meeting was arranged for a lunch break because she had no other free time:

Ms F: *What I'm still not clear about is how much work is entailed for us, as Mohammed gets going. Is it that we would be making the tapes up ourselves?*

My reply: At this stage, no, because you just haven't got the time

Ms F: *Five or ten minutes once a week would probably be all right. I was more worried that at some point you want me to start making the tapes*

My reply: I don't think that it is feasible at the moment ... if it has been beneficial perhaps we could have some preparation time?

SENCO: *If you had an assistant ... if I were to say that I would release an assistant for a block of time, something like two hours a week ...*

My reply: an assistant would need to liaise with the IST ... I'm not reckoning to set up a high quality recording studio ... it is better to be done in situ, close to what's happening on the ground, rather than producing tapes and sending them in, and then finding that they are unsuitable for students.

I had to state clearly that I could not continue to be the only person producing recordings. I was spending over an hour travelling to the school. I could not offer to visit more often

because I was starting working with another student after half term and a commitment to go on providing intensive input would have defeated the aim of passing over responsibility for the audio process to people in the school. I had not taken into account the emotional strain on support staff. Mohammed's caring supporter expressed her anxiety and frustration about dilemmas that had arisen in her work:

*every time I go into the classroom, I look through his books and find he has gone through worksheets and hasn't got the answers right ... I go back over work with him ... he's not actually, genuinely making progress ... he thinks he's finished level 5 but when we discuss it he hasn't understood most of it ... his attitude to everything is to finish it quickly whether it is right or wrong ... it definitely isn't there, the foundations like tables and fractions.*

I was interested in the examples she gave. I had noticed that adults who had learnt mathematics through predominantly traditional methods frequently cited failure in these topics as an indication that students could not do mathematics. My main concern was her anxiety about being unable to provide effective support for Mohammed through no fault of her own.

### ***Implications***

Mohammed's original teacher for mathematics, the SENCO, his IST and the VI adviser for the LEA had all been overwhelmed by demands of administrative, paperwork and covering classes for absent staff. This situation allowed little time for effective, frequent communication with a researcher. All these adults needed empathetic support. Several key adult contributors to this study succumbed to the stress of trying to meet unrealistic pressures on their time. I felt that involvement in an innovative project might be adding to their difficulties

although verbally they were in favour. I discovered that misunderstandings concerning roles and interpretations of incidents could lead to confusion if implications of introducing innovation had not been made clear and frequently discussed.

When there was no possibility of skills acquired for using audio materials to be applied in lessons, a major aim of the research - to enhance inclusiveness in mathematics in mainstream classrooms - was unattainable. But new experiences emerged through learning from each other how to work under difficult conditions and try to improve situations.

Sharing opinions about shortcomings of recorders and listening devices seemed to make Mohammed feel sufficiently secure to speak freely on topics that included mathematics and opinions and feelings about other aspects of his life. This was my first experience of working alone with a student whom I had to withdraw from all lessons. One-to-one induction sessions were useful for us to get to know each other and to experiment with the audio process but this arrangement was counterproductive concerning inclusiveness for Mohammed. Finally, Mohammed had agreed to me alerting Ms F about problems in the playground that were causing him distress but he was adamant that his parents should not know. Forming a close working relationship with a student based on mutual trust and confidentiality raised ethical issues. This was a pastoral care problem and was the school's responsibility. I was not asked for my views.

Mohammed started to take control of his own learning by making an audio revision dictionary. Through this activity I gained insight into aspects of mathematical terminology and English phrases that he did not understand. There was no need to contrive a reason for him to talk aloud. A progression to being critical of audio hardware was to suggest ways to improve script writing and narration to make listening easier.

I reflected on how I had responded to the other students' requests in school 3, to try using audiotapes and wondered if their envy that eventually culminated in physical as well as verbal bullying of Mohammed could have been prevented. Overt, active support from members of school's senior management team and staff in influential positions would have been helpful. I had not foreseen implications of the VI Adviser insisting that all communication with the headteacher would pass through her.

I did not suddenly end this mutual learning relationship with Mohammed. I assured him, as I had done with Caroline that there was no obligation or blame if he chose not to go on using audio recordings. I thanked him for his suggestions and critical feedback, which he knew I had used to improve production of recordings. He decided whether to contact me to discuss topics and request more recordings. He could send written work to me or ask for a telephone call or home visit to discuss particular problems or just return tapes to me. I kept in touch with him until the end of year 7, by which time he was seldom asking for more recordings and seemed resigned to the fact that he would be unable to achieve his initial aim of obtaining high grades in mathematics.

I learned that although it was essential to make detailed plans in advance it was also necessary to respond with flexibility, to people's feelings and beliefs and problematic events that it seemed would always occur. It was important to listen without being judgemental or over critical but to respond by taking appropriate action, as I had tried to do in the incident of peer jealousy and in the action that I took when inclusiveness in school 3 was no longer an option for Mohammed.

## Thomas

It was difficult not to form preconceived ideas about Thomas before I met him. The VI adviser Ms Y and Ms U all asked to be

present when I first met him. They insisted on giving me details about his disability and fear of mathematics. The disadvantage of this arrangement was that the number of people was overwhelming for someone without sight. Thomas' school reports indicated that mathematics was problematic for him. Consequently he had been allocated full time support for this subject. From work with Thomas, further issues were raised in relation to reciprocal learning: concerns of support staff; the need for trust and respect in collaborative communication and action; the value of a creative approach to learning. *First meeting* I did not have a chance to talk to Thomas without other adults present until I saw him out of school. Like Caroline, he remained silent when he felt overwhelmed by people or the topic was mathematics. To overcome his reluctance to talk about mathematics at our first meeting in the school, I steered the discussion towards audio technology. As soon as I handed a recorder to him I faced a barrage of questions that demonstrated his ability to question as he examined the machine by touch, as well as absorbing and applying information about the item. I involved his supporters in what resulted in being a practical session rather than the informal conversation that I had anticipated. Thomas sensed that he was the technological authority present and enjoyed extending the discussion into the realms of computers and play stations. I encouraged him to talk about his interests and explained how he could assist with audio aspect of the research. Mathematics was a secondary issue on the agenda at this stage. Thomas began visibly to relax as he spoke about mathematics in conjunction with the audio process. This was an encouraging start; the significance of no members of management or teachers being present did not become evident until I tried to communicate with them later (see chapter 4).

## *Supporters' concerns*

It was not only teachers who were concerned about Thomas's difficulties in mathematics. His supporters, Ms Y and Ms U described their experiences of supporting him in lessons:

*he says 'oh I see' and then when you say are you sure...he says 'Oh yeah' ... he's not really clear what you're talking about or he fiddles with the top of his Brailleur ... sometimes you say to him, look you've only got another ten minutes and you've still got another three questions to do.*

Ms Y's statement confirmed Thomas' extreme anxiety about mathematics, "at one stage he used to make himself physically sick, when it was a maths test day".

Later, through observing in the classroom and further communication with the supporters, I became aware of contradictions in this conversation. They were worried about Thomas's emotional reactions but they were also apprehensive about mathematics. Their lack of confidence seemed to prevent them from giving him the reassurance and encouragement he desperately needed. Their efforts to justify how they were undertaking their jobs could also have added to tension in these subject lessons.

Ms Y and Ms U were in contact with Thomas' teacher in order to produce Braille copies of mental arithmetic tests and topics ready for use at the beginning of lessons. I was not included in reviewing or planning meetings. Thomas only spoke occasionally to other students and rarely interacted with his teacher because Ms Y or Ms U were acting as intermediaries. I organised a series of training sessions for support staff, incorporating activities that had assisted Ms E and Ms W to write scripts and narrate these during the pilot study. Meetings in school 4 had to be in the staff room, which was not



an ideal setting with other people always present. These sessions, when we explored mathematics topics in depth to write scripts, reaffirmed how worried Ms U and Ms Y were about this subject. At other times they conversed easily and seemed interested in the aim of the study. Ms Y wrote and recorded a script on 'percentages' before her long, sudden, absence.

When it was decided by the school that Thomas could only use audio materials out of the classroom, I visited him at home and spent time showing his parents, with his help, how to make recordings and use the set of equipment that the LEA had purchased for him. They understood why I had decided not to continue the study in school 4. We discussed dilemmas that arise for professionals in full time jobs trying to prioritise use of their limited free time. They suggested that the home of Thomas's childminder, Ms H, would be the best possible alternative environment to a classroom.

### *Collaboration based on mutual trust and respect*

Ms H's artistic skills and genuine interest in Thomas and other children who came to her after school opened up aspects of mathematics that neither I nor Thomas would have experienced in the school setting. A working relationship gradually developed between us based on mutual respect and trust that contributions from each of us were equally important and what we promised to do was followed up with action. The disappointing aspect of this open and informative collaborative communication and action was that it could not happen within the school

### *Learning enhanced through taking control and adding creativity*

The arrangement had been that Ms H would be the liaison person to keep lines of communication open with Thomas' teacher and supporters. This did not work in practice. The positive outcome was that Thomas had to tell us which topics he was studying and strategies he was being taught in lessons. There was a

practical reason for him to converse in mathematical language. I devised a personal distance-learning program for him and kept in contact with him and Ms H by telephone and occasional visits, when requested, until the end of the academic year. Thomas took the initiative to compose scripts and record questions when I told him that his tapes could help younger students.

The element of creativity in learning mathematics could be explored in this setting. Imaginative ideas put into action ranged from making apparatus to accompany recordings to writing and narrating mathematical stories. Numerical facts related to real life problems such as feeding Ms H's dog for a week appealed to Thomas. I had no way of knowing why he had apparently not previously developed an interest in using numbers and solving problems in mathematics. It was fascinating to witness his excitement and hear the enthusiasm in his voice when he recounted his latest idea and escapade in a curricular subject that had caused so much fear when I first met him.

Thomas was adamant that he wanted to make recordings as well as continue using them for listening and working independently. Like Caroline and Mohammed he took control by making a definite choice. It seemed that because I had been willing to put myself at risk and had taken the role of a learner concerning his computer games that he felt it was all right for him to admit his own ignorance and difficulties in certain aspects of school life that eventually included mathematics. He enjoyed adding a touch of drama to his recordings by incorporating his interest in wrestling in announcements at the beginning of the original tapes that he narrated.

### *Implications*

According to people who had worked with Thomas for several years not only had his fear of mathematics lessened but also

his manual dexterity and speech had noticeably improved since he started operating the recorder and making recordings. I had not anticipated that contributing to the research would assist his personal development of either of these skills. His parents were relieved that he had changed from being "a maths phobic to a maths enthusiast". I had learned from Thomas how difficult it could be to overcome fear of mathematics that seemed to have festered and increased since he entered formal education. Thoughts about trying to identify the roots of this deep anxiety about mathematics were superseded by searching for ways to transform his negative feelings into ones of satisfaction and enjoyment associated with mathematics.

I gained insight into the difficulties that Thomas was attempting to overcome in mathematics by listening to his audio recordings and discussing the distance-learning programme with him. The new learning experiences for me were being, overtly, excluded from communicating with senior members of staff in a school and endeavouring to work with a support assistant who was determined to resist any changes in ways of working, although Thomas was demonstrating that that he was benefiting from using audio materials.

On reflection I realised that in my anxiety to work with but not against individuals had given the impression that I was in agreement with provision that existed in the schools. I had tried not to control the study every step of the way and to encourage everyone to offer opinions freely. It seemed ironic that in reality, I had sacrificed the chance to influence change for any of the students in the first four schools. Positive outcomes for me were that finding ways to deal with setbacks increased my understanding of implications of inclusiveness that can occur in practice and convinced me that learning from students as well as adults is an invaluable, informative experience.

## Personal reflections and learning

My experiences with Mohammed and Thomas led me to reflect deeply on what constitutes learning and why it is essential for each of us to acknowledge our experiences as a learner and a teacher. With hindsight I realise that I had been intuitively reacting to events and dialogue based mainly on my previous work in education as a practitioner. The most significant finding from analysing data collected was that each of us who had contributed to the research in the first four schools had experienced being a learner, regardless of our status, academic achievements or age. I had changed my role, frequently, from giver to recipient because without feedback from students I could not have proceeded with the study. This dependence on students' views and ideas placed them in a stronger, more informed position than adults, including myself. They were the users of the audio recordings; we were the observers and listeners. This had not meant that it was a foregone conclusion that their suggestions always took precedence but it did imply that their opinions carried as much if not more influence than other participants. I was asking them for advice. Adults apart from Ms R and Ms E seldom seemed to ask for students' suggestions, listen to these seriously or respond to ideas from these young people who by convention in education were the learners. The questions at this stage were whether adults in school 5 could be persuaded to develop working relationships with students in which the potential value of reciprocal learning to all participants was realised and this approach to learning was implemented to assist in promoting and supporting inclusiveness in mathematics education. A major challenge for adults, including myself, was if we could risk relinquishing control of people and situations to the extent that we allowed individuals who we regarded as less qualified and able than ourselves to lead the way. We would need to show by example that respect is not gained or lost simply by attributing

greater value to views of individuals traditionally regarded as superior.

The issue was how to create conditions that had emerged from practice as facilitating attempts to tap resources that students evidently possessed and open more opportunities to enhance and extend learning for them. I turned to literature to explore theories about learning with and from students that had become a central feature of the research.

In addressing the question 'What do we mean by learning?' Babbage, Byers and Redding (1999, p.29-31) suggest that:

an understanding of learning theory would seem to be important to support a deeper understanding of pedagogy ... the concept of style suggests individual differences as well as similarities in learning preferences ... it would seem paramount that the range and variety of learning styles present within our classrooms are recognised and nurtured ... teaching can be planned to make the effective use of materials and presentation.

Ms R demonstrated her approach to pedagogy in the way that she prepared for and presented her lessons. If other teachers had practised this interpretation of the meaning of learning, more students might have been enabled to use audio recordings. The theory is sound and obvious but in reality, as described in Chapter 4, the practicalities and implications of nurturing all styles of learning was a step too far for many of the adults entrusted with sharing their knowledge and skills with students. As noted in Chapter 4, Corbett and Slee (2000) used the term 'connective pedagogy' to emphasise the need for adults to connect with individuals' learning styles and ensure that situations where students are placed in mainstream classes but are socially segregated do not exist.

Like contributors to the book, 'Learners, Learning and Assessment' I was not searching for "overarching single theories of education" (Murphy, 1999, p.xiii). There were several interrelated strands of learning in this research. Learning mathematics using audio-recorded materials was described in Chapter 3. How learning experiences could be affected by inclusiveness and exclusiveness were examined in Chapter 4. In this chapter I focus on how my understanding of the importance of the process of reciprocal learning emerged from the necessity to depend on students and adults for feedback to improve use and production of audio materials. In this context the meaning of 'experience' was the understanding that I gained by taking an active part in events and interactions that affected all of us who were involved in incidents that arose that in some instances changed the course of the study. Glasersfeld (1989, p.11) claims that "it is almost universally the case that we interpret experience either in view of expectations or with a view to making predictions about experiences that are to come." I did not hold high expectations that the audio process would facilitate or enhance inclusiveness in mathematics lessons, after experiences in four schools but I was not proposing to enter the fifth school with a preconception that this innovatory way of complementing learning would be rejected. I was not sufficiently confident to make firm predictions about what we might learn but I felt that my expectations were more realistic and that I was better informed to make plans, knowing that it was inadvisable to negotiate entry through a third party and that I needed to communicate with people in positions of power from the start. Glasersfeld (1989, p.10) states that "to have 'learned' means to have drawn conclusions from experience and to act accordingly". I had learned an immense amount from students during the first six months. I had discovered that coercing students to communicate their thoughts and speak candidly could

be counterproductive and result in silence, as happened with Thomas, rather than opening up lines of communication. To undertake the task to 'act accordingly', at this stage, I had the advantage of combining my recent experiences in schools as a participant-observer researcher with my prior experience as a practitioner in education, albeit that my research experience was still only in its embryonic phase.

The revelation for me was how much I had already learned from the students and finding out that "learning is what happens when you take the risk of not being *competent*" (Claxton 1984, p.145). I had gained insight into what was happening in reality, from incidents that I had regarded as failures at the time. One of the most significant learning experiences for me had been discovering how to relate to students and adults in my new role, as an 'outsider' and a researcher, entering schools to introduce an innovative style of learning mathematics. However learning during the course of this study was not always straightforward or enjoyable. A conclusion reached by Boaler (2000b, p.2) was that, "although the idea that knowledge is socially shared and that learning may be represented as participation in social practice has brought new vigour to the educational community; it has also brought tensions, confusions and dilemmas." I had hoped that reciprocal learning would bring 'new vigour' and interest into school communities but it also caused consternation and doubts for some adults accustomed to being in complete control.

### *The relationship between learning and the emotions*

Adults as well as students showed their feelings of anxiety and in some cases actual fear of mathematics. Wahl (1999, p.xi) refers to the cause of this type of emotional reaction as "the pain of mathematics education carried by children, adults (former children), and many teachers (when they talk candidly)". From observation and defensive responses during

discussions I had sensed that SAs who worked with Linda, Mohammed and Thomas had felt insecure in their jobs and were apprehensive about their ability to provide support in mathematics. Getting to know them and giving them opportunity to get to know me was essential to enable us to communicate in appropriate language and feel at ease to express thoughts and feelings as well as sharing information. Communication became the essence of relationships.

Staff absences in Mohammed's school had made me aware of the immense demands on supporters as well as teachers in mainstream secondary schools. During the brief periods of contact with Ms F I gained some insight into the emotional stresses of support work for a conscientious teacher, with too many students assigned to her and too little time to communicate with students or other adults to review and plan ways of working likely to benefit all involved.

How emotions could affect a student's learning and a support teacher's work in mathematics education, in a large secondary school, was highlighted by incidents that arose in school 3 and 4. My findings from analysing data collected during these incidents reinforces the opinions of others, for example, Wahl (1999, p.24) who concludes that "math notoriously triggers a wide range of feelings. Internal observations of thoughts and feelings can strongly enhance math learning".

My awareness of how emotions can affect learning had also been increased by my experiences of working with Mohammed and Thomas and their supporters. The series of sudden, unexpected changes in the course of a few weeks in both situations was disturbing and disorientating for students and people working with them. Bruner (1986) claims that emotion cannot be separated from learning and plays a significant part in whether students are able to learn in certain circumstances:



emotion is not usefully isolated from the knowledge of the situation that arouses it. Cognition is not a pure form of knowing to which emotion is added (whether to perturb its clarity or not). And action is a final common path based on what one knows and feels.

(Bruner 1986, pp.117-118)

I did not have the time or the chance to gain the knowledge I needed to attempt to discover the root causes of individuals' strong feelings in these schools but it did alert me to the necessity to take individual feelings and emotional swings into consideration from the outset in future. In retrospect I wonder if working relationships would have been different and more beneficial for participants if we had all communicated our actual thoughts and emotions and not been intent on convincing others that we felt confident and at ease in situations.

### *Reflection in planning for learning*

I was thinking in terms of creating opportunities to develop working relationships that encouraged active participation, in which individual differences were valued, students were given chances to exercise control over their own learning knowing their ideas were being taken seriously, feelings were respected and trust instilled by knowing that action would match words. Individual experiences would depend on whether participants were willing and able to change and exchange roles. I had found it difficult to hand over control, even momentarily, in relationships with both adults and students. The funded project would require careful planning and monitoring with decisions made when and how to intervene or withdraw support, similar to ways that had been shown to benefit both students and adults. I hoped that from my recent and past learning experiences that I would be able to empathise with others reluctant to take risks

by attributing equal or greater importance to knowledge and skills of others.

Initial relationships formed with individuals taking part in this research had appeared to affect the type of communication and experiences during the remaining period of their involvement that had been a maximum of one term. First impressions and preconceived ideas had been misleading in some cases. I intended to be guided mainly by findings from analysis of the students' stories described in Part 1 of this chapter. I planned to search for, take and eventually create opportunities that would replicate working relationships that had been beneficial for individuals like Thomas and Ms R as well as drawing attention to the positive effects of creativity in mathematics that were still too often ignored.

Venues for first meetings, who attended and the way ideas and views were exchanged would set the scene for future communication. In all cases informal conversation rather than a stream of direct questions had proved to be less stressful for adults as well as students. I had found it useful to prepare prompts related to the purpose of meetings in order to obtain as much relevant information as possible within the short times allocated. It was essential to know both students' and adults' hopes and concerns about the audio process and their specific abilities and interests. It helped all students to criticise inanimate objects such as recorders and accessories and gradually progress to being critical of voices and how questions were being presented. This approach had released emotions for both Caroline and Thomas. We might never have known their invaluable views and abilities if this had not happened.

The emphasis was on making listening and understanding mathematics easier for other students in the future as well as for themselves. Instances that indicated that this could happen

had been Mohammed's efforts to record an audio revision dictionary and Thomas composing and narrating questions that other students could use. Anxiety and fear that caused tension and adversely affected learning, needed to be discussed with the aim of overcoming negative feelings. The process of learning from each other could not be forced or rushed and sometimes had been impossible due to lack and changes of staff in schools 3 and 4. Students and adults had needed empathy and support to form pedagogic relationships within which they and others, including myself, had benefited.

The tasks of finding appropriate audio equipment and writing scripts suitable for students who preferred to listen instead of, or as well as, looking at print had provided justifiable reasons for not solely focussing on obtaining right answers and employing correct techniques when answering mathematical questions. With a change in the purpose of communicating, the threat of being wrong and feelings of failure seemed to lessen for students. This way of working with Mohammed and Thomas had changed their attitudes towards mathematics, even though they had only experienced this for a relatively short time.

I had learned much from students by approaching them as individuals and adopting a flexible approach in undertaking research but by being uncritical and not questioning existing conditions and resources inclusiveness was unlikely to increase. On reflection I wondered if it would be possible consciously to develop relationships that would benefit all participants by using findings from analysing failures in the first four schools as a catalyst to motivate moving forwards and expanding the study instead of thinking in term of the first six months being catastrophic and giving up.

I would look for and seize opportunities that arose naturally to: get to know participants; create conditions where people felt at ease to talk and listen; make my role clear and

expectations for how others could contribute to the research. I hoped to persuade people in power to play an active part. I intended to withdraw from direct involvement gradually and include students in planning and reviewing meetings, adapting time and place to their requests when possible. Initial plans would take into account personal and organisational aspects of situations that I was able to find out before I entered school 5, so that I could gain an overview of the whole school not just one classroom. I would try to predict possible difficulties but also be realistic, knowing that the unexpected would always happen. I continued to research literature. It seemed that the type of pedagogical relationship that developed between students and adults depended on all contributors being able and willing to:

- a) recognise and draw on differences as a valuable resource for learning;
- b) see themselves as active learners and be actively encouraged to exercise control over their learning by making choices and taking initiatives;
- c) trust that their thoughts, ideas and feelings, if expressed, will be taken seriously by others and responded to;
- d) recognise that they can learn from other participants in the relationship and that what they contribute is important to their own and others' learning.

These elements are discussed in the next section.

Issues to be addressed in the next stage concerned: how to open opportunity to develop learning relationships that fully utilised all students' resources; how conditions could be changed if they did not support a reciprocal learning approach. There was no certainty that I would have any influence over this aspect of the study, as Nind and Hewett (1994, p.174)

comment there is "a world of difference between making experiences available and denying access to experiences". It was the latter possibility that was uppermost in my mind after my experiences so far. The other question in my mind was would skills and experience already accumulated since I began the research be applicable in a different environment and could immediate and long-term aspirations of participants be fulfilled.

## **Lessons about reciprocal learning in School 5**

I was careful from the outset, in School 5, not to pin all my hopes on adults putting their words of support for the audio process into practice. The funded project CHAMPE had to be undertaken out of classrooms because one condition was that funding must not be used to substitute provision for which the LEA was responsible.

### **Derek**

As described in Chapter 2 Part 2, my first meeting with Derek was informal and informative. I drew on my experiences in school 4 when many people were present and gave too much negative information about Thomas. I wanted my first communication with Derek to be on equal terms. I organised the same arrangement that had suited Mohammed for induction sessions with Derek. He felt at ease in a secluded corner in the learning support room. There was enough background noise and activity for us not to attract too much attention but we were able to compare experiences and share views about many topics that included but were not restricted to mathematics. We drew on our own and each other's abilities and specialist fields in the following months. The type of working relationship formed in the first few weeks was a strong foundation on which to build future communication that eventually led to complex, group, decision-making and planning

to launch CHAMPE. Issues significant to reciprocal learning that were highlighted in the working with Derek were: applying findings about reciprocal learning obtained through analysis of data collected in the first four schools; valuing individual differences; opening opportunity to more students to participate in the study; challenging existing provision; decision-making with individuals from different generation and status levels.

### *Valuing differences*

I entered School 5 with knowledge gained from six months of fieldwork that both students and adults need to feel valued as individuals regardless of their differences. When I asked Derek about mathematics in his primary school. He spoke quietly and almost apologetically, *"I didn't do much in maths. I was special needs. They thought I was stupid."* He had spent a year in secondary education but this message remained with him. He was still categorised as a 'special needs' student with dyslexia and visual impairment and he had been assigned to the lowest mathematics set. It was not surprising that he thought of himself as a failure in mathematics.

I employed a similar approach to get to know Mr D who had agreed to teach Derek in his middle band set and accepted the idea of print materials being audio recorded and used in lessons. His varied professional background had only recently extended to gaining qualifications to teach mathematics. His enthusiasm to try new ways that might help students struggling to learn mathematics was stimulating and infectious. He was appointed as the school co-ordinator for the funded project after Derek had convincingly completed the pilot period stipulated by the headteacher. Derek was not socially segregated from his peers; Mr D took responsibility for his mathematical learning in lessons and for him on a personal level as he did for other members of this group. Derek like

other students was given opportunity, with sufficient support, to fully participate in mathematics lessons knowing his differences did not devalue him as an individual (See Chapter 4).

### *Reciprocal learning with Derek*

Whilst Derek was learning from me how he could work independently in mathematics, I was learning from him how challenging it could be within a mainstream classroom if reading and remembering numbers as well as words was a problem and quantity and speed of work were used to judge success. It seemed that he had decided that the only solution was to give up the struggle and pretend he did not care. He asked questions that indicated genuine interest and desire to know more about helping with the research and assisting with plans for the project.

Mr D welcomed, Derek, the audio process and me into his classroom. If queries arose about mathematics Derek, like other students, requested help from Mr D. I gradually spent less time in the classroom as Mr D and Derek gained confidence about use of the audio system. This was the start of a 'scaffold' (Bruner 1986, p.74) removing stage or, as I thought of it, as a type of 'weaning' process, carefully and sensitively implemented in small steps with no sudden complete withdrawal of support. Judging when and how to withdraw support required sensitivity to changes in situations. By the end of the spring term Mr D and Derek were secure enough to withstand my unplanned absence from action. The learning relationship between Mr D and Derek continued to develop so that when I became re-involved my presence in lessons was less important. I spent time preparing more recordings.

Derek took the initiative to ask me to write a report for his annual review. The headteacher and Mr D agreed. Mr D

corroborated Derek's opinion that applying a learning approach that facilitated choice and valued personal and organisational differences did not have to be problematic (See Appendix 2d).

Derek and I experienced ups and downs over the following months (See chapter 4) that, as arranged, ended after he took the Key Stage 3 National tests in May 2000. I was reassured by the benefits that other participants and I had derived from putting into practice thinking that underpinned reciprocal learning from the moment that we met each other for the first time. Allowing relationships gradually to develop with varying degrees of support was an approach I replicated with students and adults over the following two years.

### *Extended access to reciprocal learning*

When we arranged to meet with the headteacher to plan and launch the funded project, Derek's prior commitments were rated as important as Mr D's or mine. Derek had evidently expected to be told when to attend. A main difference in this school was that there was strong support and interest in the research and from the headteacher. It was Derek's decision to add the letter 'E' at the end of CHAMP to emphasise the importance of 'equity' in the way that members would be regarded and treated as well as accessing information.

Opening the CHAMPE Club in September 1999 was a major event. Students could choose mathematical topics that they wanted to revise or reinforce, as well as which listening devices they preferred and decided whether they wanted to work on their own or with each other. The focus was on changing and improving the whole process to link with topics recommended in the NNS and being taught in lessons.

The target population for the research was not restricted to students with visual impairment. The Club was founded to assist any student working towards Key Stage 3 national tests in



mathematics but this did not preclude older students joining. Mr D invited the first ten members to join. They were enthusiastic about taking part in research but understandably less convinced about spending lunchtime inside "doing maths". Examples of ideas to encourage active involvement and enjoyment were: weekly news bulletins with comments from members displayed (see appendix 6); provision of resources not normally available in lessons, for example number lines and 3-D apparatus. There was no pressure to produce right answers within set time limits or compete with the achievements of other members. Suggested improvements that most members supported were implemented as soon as possible, with the understanding that further changes would be needed and development would be ongoing.

I had hoped that being an outsider I could establish a different balance of power from the conventional expert and learner relationship that tends to exist between students and teachers in mathematics lessons. Mr D proposed that attending a certain number of sessions should be obligatory with the incentive of a lunch pass and merit marks awarded. I was concerned that imposed attendance could undermine the requirements for reciprocal learning to be experienced. I thought that students should be offered a choice. Eventually I agreed that in order for students to make informed choices a trial period of enforced attendance was necessary. Mr D pursued absentees.

Derek was an excellent role model for other members. He volunteered suggestions to improve recordings and organisation. By this time he knew that Mr D and I would take his ideas seriously and action would follow. Attending CHAMPE sessions for an hour a week was inadequate for most of the other students to understand and appreciate the potential value of reciprocal learning. Derek demonstrated his leadership

qualities by asking if John could attend the Club, although he was not one of the students invited by Mr D. We agreed and this set a precedent that in future members could invite a friend for whom they were responsible if anti-social behaviour disturbed other members or resources were damaged. Dual listening devices helped to develop the social aspect of the Club. My experiences of writing scripts and narrating in schools 3 and 4 proved invaluable when discussing with members ways of making recordings for revision purposes. Derek, John, Norma and Alice were the only four out of ten members who piloted CHAMPE who, without reminders or cajoling, continued to sacrifice their lunch break and withstand critical comments of their peers.

### *Taking a risk: challenging traditional school hierarchies*

The practice of reciprocal learning presents a challenge to the traditional hierarchy of power and authority in schools in various ways. Derek's decision to tell me that he was again in difficulties in accessing information in print materials in lessons raised an ethical issue. He told me in confidence at the end of a CHAMPE session. He was worried because he felt it was his fault and he should not be criticising a teacher to another adult. I reassured him that no one was to blame but I could not change matters unless I enlisted help from a member of staff. I suggested the headteacher but accepted his preference to tell Mr D, if I thought this was necessary. In my opinion this incident was an immense step forwards in the development of a reciprocal learning relationship. A student had made the first move to seek a change to improve matters for himself. He evidently felt able to trust adults enough to express his thoughts and feelings. This was an example of "transformative learning" included by Collins, Harkin and Nind (2002, p. 3) as one of "the features of good learning". Transformative learning is defined by Hart, Dixon, Drummond and

McIntyre (2004, p.166) as "a potential for change ... that things can change and be changed for the better, sometimes even dramatically, as a result of what happens and what people do in the present". Derek had been able to perceive and understand a situation from viewpoints held by people he regarded as his superiors academically and socially. Most importantly he had achieved this without confrontation. This happened after he had been contributing to the study for two and half terms and was an indication that forming reciprocal learning relationships needs to be allowed to proceed slowly. It is dependent on people's reactions to the idea of changing ways in which they interrelate with others and also on incidents that occur to prevent this happening. Derek was not the only student who benefited as a direct result of his courage to take a risk. Mr D eventually moved students, who wanted to go on using audio materials, into his classroom.

Derek's request to move into Mr D's class demonstrated that he was willing to take action on behalf of his friend as well as himself. Although he had recognised that it must be difficult for teachers to have students with reading problems in their classes (See Chapter 4, p.254), he had not thought in terms of implications of moving to another set for teachers or his fellow students. The idea had not occurred to him that this could create a precedent. I was impressed by Derek's awareness of feelings of others although he still liked to portray himself as a non-conformist not respecting adults or caring about the code of conduct displayed in all classrooms.

Some members of the mathematics staff were against the students being allowed to transfer to another set. They argued that this could become the norm and organisational plans agreed in the department would be overturned. I interpreted this reaction as a fear of adults to take a risk to grant a request from a student, in case this led to others following suit and

consequently the balance of power that enabled them to retain the status quo could be jeopardised. It is open to debate whose views should have prevailed. Mr D decided that the only way of resolving this issue was to move students into his own set without drawing attention to the transfer. He skilfully and quietly carried this out. The significance of this incident highlighted the need to recognise and make explicit issues of social conventions and status when attempting to establish reciprocal learning relationships.

I gave a carefully prepared explanation to students who had been in Mr D's set for a term, basing content on Mohammed's experiences of peer jealousy after the talk I gave to his class. My talk was politely received without comments or questions. It was a year later that I found out that not all the students had been present and some had not understood why Norma, Derek and John were using audio recordings. Derek and John chose to work together in lessons. John helped Derek gain access to print information displayed on the board work. Derek was able to reciprocate by helping John with mathematics and audio equipment. Norma, who had reading difficulties and lacked confidence, formed productive reciprocal learning liaisons with several other students in the class. These were the first instances of mutual learning that I had observed between students in mathematics lessons since the research started. It was an important feature of reciprocal learning that naturally arose but needed to be carefully monitored. Over dependence might interfere with the 'giver's' concentration but it was the beginnings of conscious interchange of roles from being the knower and informer to being a learner and understanding the problems inherent in both roles.

### *Problems: resolution within a reciprocal learning approach*

A reciprocal learning approach implies that problems should be resolved through active collaboration between all participants

I described in chapter 4 the sequence of events that threatened to culminate in Derek ceasing to use the audio process. The way in which peer pressure was finally resolved was a learning experience for all of us involved. Derek and John had reached the point at which they thought the only solution was to stop using audio materials in lessons. They felt that they were "an easy target at the back ... if you think about it we are still a separate class". They thought the gestures from other students were meant to indicate that they were "a bit loopy and backward". Having observed this happening I agreed.

A series of frank discussions followed. Adults involved were the headteacher, the mathematics manager, Mr D and myself. We never knew how many other students were giving their opinions unbeknown to us. With Mr D's agreement I obtained the headteacher's permission for Derek and John to attend a meeting. John chose not to be present. We all had enough time to express our views. By listening to each other and taking seriously ideas differing from our own, it was agreed that Derek and John should be given a chance to resolve the problem without adult intervention, as they had requested. Several of us voiced feelings of foreboding but fears proved to be unfounded. They confronted the issue themselves. I made sure that I passed on to Derek the complimentary comments made by adults after this meeting about his ability to debate the issue with people at all levels. None of us knew details about how the boys persuaded the troublemakers to let them work without harassment and we did not ask, because no further incidents occurred. An impending crisis had been competently resolved without any fuss. The consequences of this resolution meant that those who chose to follow in these students' footsteps and use audio material for the national tests were offered similar opportunity the following year.

Barbara, who was one of the main instigators of peer pressure, came to an unrehearsed video recorded interview session after SATs had finished. She disclosed her suspicions about the audio process and claimed that she had not understood the purpose of the process. She was one of the students who had not been present when I gave my introductory talk. She knew nothing about my involvement in the 'peer pressure' affair. Mr D was ill on the day of the interviews. It could have been a difficult session but the students were determined to make it a success. They took turns to operate the camera, were quiet during each interview and voiced their views openly in the final discussion. A few days later Derek told me the whole story. The incident had historical origins. Barbara had always obtained better marks for mathematics in their primary school but by using the audio recordings he was now the higher achiever.

### *Summary of lessons learnt from Derek*

Derek's final feedback indicated that he had not only discovered a complementary medium that he had not previously used but also had opportunity and time to experience and develop reciprocal learning relationships with adults as well as other students. His replies to questions about how he used audio recordings for the SATs summarised his thoughts about use of audio recordings, "when you're under pressure you just can't read the questions. If you listen to the tapes it helps, just to flick through it ... sometimes I just listen to the tape and look at the diagrams". One use of audio materials for him had evidently been to reduce anxiety. He could find questions without needing to ask anyone for assistance. He readily offered his ideas for other students who may want to use audio materials in the future:

*they should start with tapes at the beginning of Year 7 because at the time where I started I was*

quite low. I've got higher but I'm still not like high enough. Like I can get a 'D' but I can't get a 'C'. If they do it as soon as they enter it might boost them up actually to get into the intermediate class to get that 'C' but I can only still get a 'D'.

Derek's final verbal contribution to the study was, "I've coped but without the boost of the tapes I wouldn't have been able to do it. When I had the tapes it benefited me". These succinct observations were enlightening.

### *Transformative effect of reciprocal learning*

Work with Derek demonstrated how reciprocal learning approaches can transform learning and inclusiveness. Mr D created and maintained an environment in which diversity was valued. He was totally committed to inclusiveness and able to apply his beliefs and theories in practice. For example, Derek required more time to finish tests. Mr D explained his effective way of dealing with this difficulty:

*he started the test at the same time as everyone else but I did point out to him that because I was trying to keep an eye on thirty other students, I wouldn't be able to help him all the time. Any questions that he found difficult to listen to, please could he leave them and then we'd take some time to go through them and he actually came into this room and at the end of the test for another fifteen minutes, where I just read the questions he hadn't been able to understand to start with*

Mr D had expected Derek to take responsibility for deciding which questions he had not been able to understand from the audio recorded version and Derek had responded to his expectations. For a student who was disaffected with mathematics and school in general, eighteen months ago, this

change in interest and attitude gave some indication of just how far he had moved forwards on a personal as well as on an academic level. The invaluable contribution that Mr D had made to bring about this transformation had enabled him to experience a different way of learning and interacting with adults that he had found beneficial and gave him the independence he desired.

I had devoted much of the time that I was unable to go into school 5, in the summer term, to train the six members of the Narrating Service that I had formed to produce audio recordings. It was reassuring to receive positive feedback from one contributor with many years experience in education including a headship. He chose not to come into the school but was interested in the detailed feedback from students using the tapes. After several attempts to write scripts he commented:

*that was the most wonderful exercise ... without realising it, as a teacher, I was using a visual line and I wasn't explaining it properly to the class. I didn't know it till I actually had to sit down and scripted it ... the rows and columns have disappeared, you've got to go back to basics, further back and that's why I think the whole thing is extremely interesting and exciting for maths teachers ... I really do believe that this is a tremendous asset for any school to have*

By May 2000 I had discovered that conditions that had been shown to be conducive to tap resources that students did not usually reveal in relation to mathematics were also ones that enabled and encouraged adults to communicate more easily and exposed their hidden beliefs, talents, abilities and interests.



## Reflection on the concept of reciprocal learning

Reflection on work in the five schools led me to the view that reciprocal learning is an activity based on giving and receiving, with contributors respecting and valuing each other's uniqueness as much or more than their own. Gaining experience, knowledge and skills is as important as imparting these to others. The challenging activity for many of us involved in this study was to allow ourselves to be influenced by others whom we regarded as less experienced, knowledgeable and skilful than ourselves. It had become evident that the potential use of the audio process and in some cases inclusiveness for students could be facilitated through forming reciprocal learning relationships. To discover which aspects of reciprocal learning were significant in incidents when outcomes for students were positive, I needed to identify activities that had been shown to be essential in these situations.

Table 5.1 (p.310), shows the characteristics of reciprocal learning that emerged from analysing learning that cumulated during the study. These were described in detail in the two sections of this chapter. Each characteristic is listed with the purpose summarised, examples given and data sources noted.

Table 5.1 Characteristics of reciprocal learning

<u>ACTION</u>	<u>PURPOSE</u>	<u>EXAMPLE</u>	<u>DATA SOURCE</u>
LISTEN	extract & recall information; respond to ideas & views	maths topics CHAMPE	1:1 work group decisions
SPEAK WRITE	describe & explain to help judge understanding	scripting & recording	induction narrators
TAKE RISKS	Try new ways of learning; relinquish control	CHAMPE preference	observation participation
SHOW EMOTIONS	understanding how feelings can affect learning	frustration elation	informal interactions
CHOOSE	control own learning realise limits of choice	adults rely on students	participant- observation
QUESTION	be critical without confrontation or blame	improve recordings	interviews
COLLABORATE	respect & value opinions difference	joint planning	observation discussions
CHANGE ROLES	sense when & how to change/exchange roles	mutual learning	induction & reviews
SHARE	Get to know interests, abilities & aspirations	personal backgrounds	informal dialogue

## HELP

Aim to benefit others  
as well as self

observation  
participation

mentoring

## CHALLENGE

question: existing provision  
own/others achievements

observation  
implement ideas

improve  
conditions

## SUPPORT

Know when/how to intervene  
provide/withdraw support

observation/discussion  
implement ideas

guidelines  
for all

## TRUST

Know that: intentions stated  
will be implemented in action;  
opportunities will be opened  
for voices to be heard;  
responses will be made

video/audio records;  
logs; notes;  
observation  
participation

enable students to  
improve situations &  
audio process for  
themselves

Planning production and use of audio materials for lessons and the funded project had opened opportunities for more adults and students to experience collaborative communication and action related to mathematics. This led to a shift in my thinking that concerned pedagogical issues, which I had not considered when I began the research. How to communicate and judge whether students had understood and could apply knowledge and skills that they were offered are issues that arise in any form of sharing information. In this study, without a full teaching commitment in classrooms, I was able to prioritise my time to concentrate on these issues.

Students' thoughts and opinions, when expressed, were an invaluable resource for triggering new ways of proceeding and interpreting situations, which had not occurred to me or other adults. Before and during the time I spent in school 5, I searched literature to find similar learning approaches that had already been theorised and might be applicable in a large comprehensive school. References to writings of others that I make in this section relate to incidents that arose that were significant to my learning and influenced thinking and action during and after I finished fieldwork.

Introducing the audio process into the homes of Thomas and Mohammed after use had been excluded from classrooms had reinforced my belief that it was essential to develop "reciprocal understandings between home and school" (Glynn, Berryman & Glynn, 2000, p.10). McNaughton, Glynn and Robinson (1981) authored The Pause, Prompt and Praise literacy project founded in New Zealand. The scheme stresses that communication between home and school "requires careful consideration of the balance of power between home and school."

Reciprocity was a concept used by Phillips and Bredekamp (1999, p.441) in the context of working with parents of pre-primary children in the Emilia Reggio school in Italy: "reciprocity

assumes both parties to be powerful and active". Based on the amount that I had already learned from students I was convinced that students also warranted being regarded as powerful, active participants whose contributions deserved equal consideration that should be as influential in decision-making as those received from adults.

People in the home and school needed to know about any changes in individuals who worked with students and the variation of ways in which they were allowed to learn mathematics. From past experience I was aware of some of the difficulties that can arise in communication between home and secondary schools. These come as a shock after the close contact between families and adults when students are in primary education. Mohammed's parents were especially appreciative. He had not told them that he was using audio recordings for mathematics and they were unhappy about the loss of contact with him and the school since he started his secondary education. The importance of the holistic aspect of reciprocal learning became apparent and was an integral feature of this style of learning. Glynn et al (2000, p.11) suggest that "effective collaboration requires mutual acknowledgement of knowledge and expertise and of interdependence in problem solving". A priority was to tackle the task of establishing communication and collaborative working with students with the aim of extending my own and other adults' awareness and application of the resources they possessed.

Nind et al (1994, p.218) define reciprocity as "the term for the concept of mutual give and take exchanges in which influences are two-way". They also cite 'mutual enjoyment' as an essential principle of early learning in their 'Intensive Interaction' approach. My view is that these writings support aims of reciprocal learning for students of any age and ability. I had experienced how this had been possible with

Caroline, Linda and Thomas. Mohammed also made valuable contributions during one-to-one working sessions out of lessons, it was a question of conjecture if this could happen in classrooms.

## **Pedagogical issues**

Reciprocal learning raises important pedagogical issues. Pedagogy in the schools had seemed to be regarded as teachers' territory but there were many other adults with whom students and I formed working relationships who could and did benefit from reciprocal learning. I acquired knowledge and ideas from them as well as students that I used in later phases of the research. I wanted to retain the idea of wholeness that linked the term 'reciprocal' with its definition in mathematics where 'the multiplier gives unity'. The aspect of changing and exchanging roles was encapsulated in other definitions of 'reciprocal' that included interdependence and interchange. Both these activities had been vital to communication and action in the first four schools and would be core activities. Changing and interchanging roles would continue to be a major feature of the study. I shared the view of the value of 'interactive learning' being that "both teacher and the student(s) are teachers and learners" (Brown et al, 1991, p.1). I was not thinking in the terms of 'the expert' and 'the learner'. The term 'expert' has long been associated with mathematicians and I feel strongly that this portrays an image of superiority and power that is still a threat to students. The description "more knowledgeable" (Wray, 1997, p. 19) was how I hoped students would view others who were sharing information and skills with them. When roles were reversed I hoped they would think of themselves as being 'more knowledgeable' rather than the expert or the superior person. The value of utilising students' strengths and abilities had been apparent in schools 3 and 4. Increased confidence and

enthusiasm was noticeable with Mohammed, Derek and members of the CHAMPE Club as they persevered with making recordings that tested their ability to communicate in mathematical terminology. Parents of Thomas and Stephen commented on their more positive attitudes towards mathematics and actual enjoyment of the subject. Stephen's mother remarked that, "*the only homework that Stephen likes doing is the audio maths*". This was the same work that all students had been set but as Stephen explained to me, he could do it on his own without straining to see print. This outcome convinced me that it would be productive to be aware of and apply the characteristics of reciprocal learning from first meetings with individuals. My intention was to utilise to its full potential valuable resources that students evidently possessed but tended to assume were not needed in mathematics. I wanted to exploit this source more extensively to find out if this might lead to students' experiences in mathematics becoming more positive and pleasurable and their interest in the subject lasting longer and giving them greater satisfaction. Questions that were in my mind at this stage concerned how to introduce and support formation of reciprocal learning relationships and encourage adults as well as students to take a fresh look at mathematics and ways of working with each other.

It was difficult to foresee and plan ahead to ensure that my vision of developing reciprocal learning relationships between students and adults would be possible in the final phase of the research but I was prepared to take a risk of finding out. Hart (2003, p225) explains how one teacher, Julie, sought to establish working relationships with her students, noting that "perhaps the most important state of mind that Julie seeks to nurture is 'feeling equal' ... she encourages collaborative interaction, where everybody is recognised as a resource for the group". This aptly describes my intentions after two years of fieldwork. I had not previously considered making explicit a

way of interacting with students that in retrospect I have realised had been, for me, a spontaneous natural way of interacting with students

Having found few references to reciprocal learning in the form in which I was applying it, I searched literature and electronic sources, again, for work in which reciprocal learning is cited as a means for developing working relationships between students and adults in secondary education. At a research seminar I began by asking participants 'what is your interpretation of the term reciprocal learning?' Responses ranged from 'I have never heard of it' to comparisons made with other types of learning relationships, for example 'Participatory' learning (see chapter 2, p.126), 'Authentic Relationships' (Hopkins et al, 1996), Involving Pupils in Practice (Jelly, 2000). There were principles from each of these styles of learning that described some of the features that had emerged as significant for reciprocal learning. The main difference in this study was that research revolved around adults not only recognising that the phenomenal resource of students is being underused, but also being willing and able to change and interchange their roles with students in secondary mathematics education in order to increase inclusiveness for all students.

Smyre (2002, p1) reports on a project in the USA in which 'reciprocal learning' has been developed as a means of adults in the building industry forming working relationships. Acknowledged experts in this field discovered that they had much to learn from their students. Smyre explains how he questioned his thoughts and reasoning by asking:

what if learning could become a two way street for adult learning ... that as I helped frame the learning experience for those whom I would mentor, they would



help me think about new ways to evolve learning experiences without a traditional scope sequence.

I discussed this project with him and could identify with his description of how working relationships can be changed from challenging and confronting each other's expertise and knowledge to sharing arts and abilities we have acquired even if age, status and titles, separate us on a superficial level. Carrington (2004, p.32) challenges the fact that 'supervisions' of students in professional training are seen as "one-way processes with the supervisor providing and the supervisee receiving ... it should also be acknowledged and actively encouraged that professional development can take place for the supervisor as well". A similar assumption is made about adults in schools being the providers and their students always seen as the recipients. My vision is that the value of reciprocal learning will be recognised and publicised so that gaining knowledge and experience in mathematics will no longer be "an essentially unilateral process" (ibid, p.33). Findings from this study reinforce the conclusion reached by Ainscow (1999, p.9) that effectiveness "in encouraging pupil participation is the way available resources, particularly human resources are used to support learning ... a range of resources that is available in all classrooms and yet is often poorly used [is] that of pupils themselves."

## **Mentoring**

I found common ground between my research and a project in progress in Australia. Hurwood (2003) who was about to launch a new project for mentoring between adults described it as "a personal giving and sharing of experiences, feelings, skills and encouragement." I opened the discussion by asking how she ~~thought~~ reciprocal learning with students in schools would differ from mentoring with adults. As I listened to her explaining ideas and thinking that underpinned the project, I

was aware of similarities to my research. Both involved interchange of practical and theoretical knowledge and experiences. The main differences were that reciprocity was between adults and the definition of mentoring was prescriptive with defined goals. I did not feel able to judge which features of this approach were particularly relevant to my study without knowing more about how intentions were being implemented in practice and that was still in the planning stage.

I did not pre-plan peer mentoring in mathematics. It naturally emerged as an activity in the CHAMPE Club, mainly due to lack of volunteers to run induction sessions. Watson's (1994) interpretation of mentoring mirrored my own, although her account concerns teachers working with student teachers. She claims that, "it would be impossible for one persons to tell another exactly how to teach" and defines a mentor as a "a guide and support" (ibid, pp.2-3). Stephen and Teresa employed differing styles of mentoring. After a short period of training, they launched confidently into the process of mentoring members' mathematical learning but both soon sought guidance and support. One of the aspects they found most difficult was "knowing when and how to allow the student to take over" (ibid, p.5). I also learned from this experience that "having students working intensively with us forces us to reflect on our own practice and therefore makes us better teachers" (ibid, p.11). I held the opinion that this benefit also applied to researchers.

Reading that provoked further thoughts and ideas about how to develop reciprocal learning relationships with students included distinguishing between co-operative and collaborative learning. Collins, Harkin and Nind (2002) conclude that "collaborating is not just working together towards a common end but also working across differences and boundaries ... goals are shared and only achieved by working together ...

opportunities for younger learners to collaborate in formal educational settings remain relatively rare" (pp. 111-113). Throughout the study working together in activities with participants had inevitably depended on communication and had determined the type of relationships formed. Murphy (1999) stresses that it is important to "maintain a distinction between the notions of learning to collaborate versus learning through collaboration" (p.259). She gives examples from a research study commenting on differences that occurred when collaboration was unplanned, planned and not supported, planned and supported (ibid, pp.263-267).

In contrast Johnson and Johnson (1987) provide detailed descriptions of how co-operative learning was introduced in the USA with aims clearly stated and tabulated with goals set. They recommend that, "students must be taught the social skills needed for collaboration" (ibid, p.13). They cite teachers as the experts. The element of allowing and enabling individuals to find out for themselves, with appropriate support provided, was a crucial component in the process of reciprocal learning. Murphy (1999, p. 260) stresses the need in collaborative situations for students to be "allowed to construct and reformulate tasks for themselves". It was the aspect of both adults and students making discoveries about knowledge, skills and each other, from practical experience, which was central to reciprocal learning.

Implications that Murphy notes ~~are~~ are applicable for extending research on reciprocal learning. She suggests that "pedagogy will need to change if skills of collaboration as well as collaboration for learning are to be fostered in classrooms" (Murphy p.274) and that there is a need to "teach and support a range of communication skills" (ibid, p.275). Improving communication was one of the developmental aspects of reciprocal learning that was needed. All participants needed to

understand the aim of the study and roles that they may need to take. Individuals at all levels needed to play a proactive part in decision-making and implementing ideas agreed to be worth trying out. Time and commitment would be needed to persuade more students and adults to find out if reciprocal-learning relationships could facilitate inclusiveness in mathematics. In the following section I describe how I continued to learn more, about others, and myself, through involvement in the study.

## **Proactive development of reciprocal learning in School 5**

It was the introduction of self-checking tapes and opportunities to be involved in decision-making and implementing ideas to improve these that further exposed the potential value of developing reciprocal learning relationships with students and adults willing to try this way of working. The opportunity for students to experience forming and developing reciprocal learning relationships to facilitate working towards Key Stage 3 national tests ultimately depended on the CHAMPE project. The barriers to inclusiveness in mathematics lessons for Stephen and other students in his year were described in detail in Chapter 4.

In School 5 the challenge was how to exploit and apply all that had been learnt from both failures and successes as interpreted by individuals who might be seen as beneficiaries or victims. By opening opportunities and encouraging individuals to form reciprocal learning relationships I had moved beyond the stage of development where reciprocal learning had been "used and practised unconsciously and spontaneously" (Vygotsky, 1978 p.90). The next step was consciously to monitor how this way of learning might lead to enhancing and extending inclusiveness in mathematics and socially as had happened for Derek, through developing the process in other environments with different

individuals. Transcripts of participants' own words are provided in this section. There are audio recordings of these conversations that conveyed feelings as well as words and the type of environments in which communication took place. If conditions did not exist to support and enable participants to put into practice the actions identified as being essential for reciprocal learning relationships to be formed, the intention was to influence change to improve situations and allow more contributors to experience this style of learning. I was interested in further discoveries that would provide greater insight into learning for us all. Table 5.2 shows developments of the characteristics of reciprocal learning with examples of action that was implemented in practice.

Table 5.2 Development of reciprocal learning relationships

<u>ACTION</u>	<u>DEVELOPMENTS</u>	<u>EXAMPLES</u>
LISTEN	increased complexity of content & presentation	audio recordings used for Key Stage 3 SATs
SPEAK WRITE	decision-making with people at all levels	Stephen & Jeremy planned audio library with adults
TAKE RISKS	encourage creativity; let others exert power	students publicising & running audio library
SHOW EMOTIONS	more opportunities & help to release emotions	expressing feelings encouraged in CHAMPE
CHOOSE	more topics & attending CHAMPE optional	additional topics recorded if requested
QUESTION	consider whole situations events & dialogue	changes not restricted to situations in classrooms
COLLABORATE	be proactive in putting words into action	Stephen & Jeremy ran CHAMPE without adults
CHANGE ROLES	empower all individuals to learn & lead	Daniel: creating website: learning to explain
SHARE	move beyond audio technology & mathematics	increases in self-esteem & confidence

## HELP

apply the art of receiving  
& giving appropriately

students mentoring each  
other in CHAMPE

## CHALLENGE

make improvements  
without external incentives

Daniel: adding sound  
track to website

## SUPPORTING

students & to  
'scaffold' for each other

learning from each other  
when and how to support

## TRUST

match action to words;  
supply appropriate resources to  
support reciprocal learning

CHAMPE organised and supported  
within the School Library to  
enable aims to be realised

## Stephen

When I first met Stephen he was self-depreciating and did not converse easily. He was blaming himself for all the problems that he was encountering in mathematics. He did not voice his views candidly until we had worked together for a year. He was more at ease talking in the library than in an unoccupied room. It was in this environment that he spoke about his difficulties before he had a chance to use audio-recordings (see Chapter 2, p.158). Working with Stephen revealed how reciprocal learning relationships, even when they are seemingly well established, are susceptible to environmental changes and personal reactions.

### *Transitory nature of contexts facilitating reciprocal learning*

In Ms P's set conditions existed that supported the formation of a reciprocal learning relationship between her, Stephen and me. This was similar to the one that benefited Derek, but disappointingly in this case it was not given sufficient time to develop before it was ended in spite of endeavours to maintain it. Stephen was transferred back to Mr N's set. I made sure that I noted absences and explained the aim of the research and my role in the school to them when they attended the next lesson. I was determined to avoid misunderstandings and missed information that had caused difficulties later in the cases of Mohammed and Derek. Stephen's interpretations of relationships between himself and other students differed from the description given by Mr N who was his mathematics teacher throughout Year 9. Stephen recalled remarks made to him, "they use to say 'Oh look at him he's listening to music and try and fiddle around with the tape and that ... I used to tell



them to go away and leave me alone". On another occasion his remark about being allowed extra time for completing tests again indicated that he was sensitive to his peers opinions, even though he gave the impression of not caring. He explained why he had not used additional time, *"It's not so much that it shows you are different but if you're sitting there at break time, everybody like says 'what you staying there for?', it used to be a hassle, so I started finishing with everyone else."* Mr N dismissed any thoughts that comments from other students might have caused problems for Stephen, *"He's sensible enough to take all that sort of thing in his stride"*. I found it interesting that Stephen had remembered these remarks when he was expressing his thoughts about using audio recordings for class tests, just before he finished contributing to the study.

A further example of the transitory nature of what it is that facilitates reciprocal learning can be seen in my experience of working with Matthew. Matthew was in the same set as Stephen when I started working with Year 8 students at the end of the summer term 2000. He was far more forthcoming than Stephen. He was the first student to ask me in a lesson, with peers present, if he could try using the audiotapes to help him in mathematics. His teacher Mr I agreed but at the end of the term he commented, *"I think it wasn't so useful for him. He reads generally quite well and possibly he just enjoyed the novelty of it more than anything"*. Matthew was one of nine students who opted to use audio recordings for the Key Stage 3 national tests but was not given the chance. He took the tests in a separate room with staff from the SEN department invigilating. I was interested in why he had not asked for help. His fluent, impassioned

description of his reading ability, given sitting in a noisy corridor, did not tally with his Mr I's opinions:

*I was too scared ... the literacy people said if you need anyone, to put up your hand but I didn't, I thought if I kept asking they might get the hump or somethink ... as I said to my mum before, it is embarrassing for people cleverer than me, like people take the mick out of me sometimes because I can't read or anything, if I put my hand up I look like a person who's asking for answers.*

My involuntary reaction was to laugh in exasperation. I was thinking how ridiculous this arrangement had been for Matthew. He could have been given opportunity to use audio-recordings and would not have had to ask for help to read questions, if he had been allowed to use this learning method in lessons. Matthew immediately thought that I was laughing at him. He had been distressed by his experiences during the tests and blamed himself for not having asked to use audio for SATs. This incident reinforced my feelings of inadequacy in understanding the emotions of students who gave an impression of being confident and uncaring but below the surface were enduring turmoil that they were desperate to keep hidden. On reflection I realised how much I had learned from Matthew in a few weeks. One comment made by Mallon (2000) about the peer tutoring programme 'Pause, Prompt and Praise', was that research had shown was that, "it could be used effectively by tutors after only sixty minutes training". Matthew demonstrated that it was possible to acquire the basic operating skills for the audio process in thirty minutes. Most students chosen to help with the research in school 5 restricted their responses to 'yes',

'no' or silence and tended not to initiate conversation in mathematics lessons with adults, including myself. Matthew was an exception. I was disappointed that his chance to contribute to the study in lessons was only brief. He was not sufficiently interested to sacrifice his lunch hour to attend CHAMPE. If opportunity had been kept open for him and he had been sufficiently motivated and confident to insist on continuing to use this process, outcomes for him could have been very different.

These examples illustrate how misinterpretations and misunderstandings can significantly affect the way in which working relationships that are tenuous and superficial can quickly be destroyed with trust lost in the process. Previous learning was applied to get to know participants from the outset with opportunity offered to express concerns and feelings. Focussing on strengths and aspirations revealed interests that were incorporated in activities that were an asset in the CHAMPE Club, for example Stephen's enjoyment of helping younger children at home. He experienced reciprocal learning in Ms P's classroom for a short period during which his differences were respected and valued and inclusiveness in mathematics was given priority. Other students were not given this chance unless they attended CHAMPE sessions.

### **A whole school approach to reciprocal learning**

The example of planning and running CHAMPE illustrates how reciprocal learning needs to be taken seriously at whole-school level. The head teacher suggested moving CHAMPE into the main school library. The senior librarian and her staff enthusiastically agreed. I seized the opportunity to start creating an environment which I hoped would be conducive to establishing and developing reciprocal-learning relationships between people at all

levels. The project had been running for a year and students who had regularly attended the Club knew that changes had been made in response to their criticisms and suggestions (See Appendix 2b). For example a greater range of listening devices had been purchased and presentation on recordings altered to make it easier to find sections and questions. Members of the Narrating Service continued to improve their own script writing and narrating in response to suggestions from students who were listening to recordings. I arrived at the same the conclusion as Kellett and Ding (2004, p.172) that "the best way adults gain access to children's worlds is by fostering greater participation of children and young people themselves. The more children are given a primary research voice, the less adults will be required to 'interpret' their worlds".

### *Devolution of power and leadership*

One of the purposes of the planning sessions to transform the Club into an audio loaning library was to establishing effective lines of communication with other individuals likely to become involved. New key participants in the project were the Senior Librarian and her staff and the Head of Media Resources and his helpers. This was an opportunity to find out how different individuals reacted to taking risks to interchanging roles, relinquishing control and allowing people in less powerful positions to take the lead and learn from them. The official planning committee comprised of Stephen and his friend Jeremy, Ms Z assigned by the SEN department to help and me. Everyone seemed visibly to relax when they realised that there was no one right way of organising CHAMPE. At first Jeremy and Ms Z were hesitant about expressing their views. They were

listeners rather than speakers. Stephen eagerly voiced his ideas and opinions. I emphasised the idea of sharing knowledge and skills with other students, remembering our own pleasurable experiences in mathematics and trying out ways that had made the subject easier for us when we were learners. The other requirement was to try to understand challenges and problems from other people's points of view and to think of ourselves in other people's positions, for example what might our views be if we were a younger student, a teacher, the person in charge of the library or media resources or in my position (named by Daniel as the 'Director of the project').

We started brainstorming with all issues and ideas noted but no comments made. Points noted in one session were used as an agenda for the next, with specific tasks agreed for us to think about and come to the next meeting ready with more ideas for how to organise the borrowing procedure and improve production of recordings. We discussed and tried to put into practice how to question each other's ideas constructively without being influenced by our pre-formed views of the person who had put forward a suggestion. I was delighted when Jeremy felt confident enough to question my version of wording for a poster and then produced a clear colourful edition of his own to show us at the next meeting. Ms Z began to give her opinions. Stephen became less ebullient and took time to consider our ideas as well as justifying his own. There was no designated chairperson. We all had to be prepared to explain reasons for choosing one idea rather than another and sense when to speak without interrupting someone else discourteously. We did not invite students to start borrowing, until the four of us, the head teacher and the senior librarian were in agreement that

it seemed that plans for a system to run a combined Audio Mathematics Club and Library were as sound as possible.

Discussions and role play that took place during planning the change of CHAMPE from a Club to an audio library presented opportunities for all of us to experience communicating with individuals more and less competent than ourselves in spheres of learning not restricted to mathematics. Thinking of ways to advertise the Audio Library naturally introduced an element of creativity that later extended to looking for ways of interesting and assisting understanding of mathematics for students who came to the Club/Library. Ideas and actions suggested and later implemented were not totally self-orientated. They were intended to provide ways that could be applied in practice to benefit all students in the future.

### *Student leadership in reciprocal learning*

Stephen offered to run a CHAMPE session with Jeremy when I was unable to go into the school and Ms Z had changed her mind about helping with the project. This was an important turning point. Both students started to work on equal terms with me instead of expecting me to always initiate ideas and take action. The reciprocal learning relationship that developed between Stephen and the younger students who joined the audio library was similar to Hurwood's (2003) definition of mentoring. Stephen became a cross-age tutor. Mallon (2000, p.211) argues that cross-age tutoring, "gives the role of tutor to the at-risk student; reinforcement of student accomplishments, talents, leadership and participation." These were some of the positive outcomes for Stephen that resulted from this new experience.

I had not anticipated handing over administration so soon. I was surprised by the confidence and maturity shown by Stephen and Jeremy to communicate with me and other adults in the school library. They were committed to dedication to the aim of CHAMPE to welcome and include all interested students. They questioned the organisation of the filing cabinet that housed equipment and the tapes. We agreed that the existing provision was not suitable. To make improvements labelling of tapes was changed to make it clearer to know the topic and enable people like Stephen with visual impairment to see information more easily and wheelchair users and shorter students to reach items for themselves. We allowed enough time after sessions to discuss issues and decide if more changes should be made. Both students tended to instruct younger students rather than encouraging them to explore different strategies. I wondered whether they were basing their methods on their own experiences of learning mathematics. We talked about finding out why students chose certain topics and ways to get to know how much they already understood without just asking questions that they could answer with yes or no. The idea of working, collaboratively, with a sense of equality in the learning relationship was one of the crucial characteristics of reciprocal learning. Each individual would experience being a learner at some moments but not necessarily only in mathematics.

Stephen and Jeremy took on the challenging tasks of scripting and recording to gain their Mathematics Assistant certificates that would qualify them to explain mathematical topics to members attending CHAMPE sessions. Their original and final recordings are well worth listening to and could be used in other schools to provoke discussion and draw attention to the difficulties

that may go unnoticed until students are required to talk about mathematics aloud. Their own understanding or misunderstanding of topics was demonstrated by their ability to give meanings to symbols, explain in their own words contents of questions and suggest strategies that could be employed to work out answers. I gained insight into some of the misinterpretations of terminology and how students attempt to conceal their confusion concerning mathematical language and symbols. They discovered the amount of thought, preparation and attention to detail, necessary, to produce high quality recordings. Stephen preferred to help the students who came to borrow tapes while Jeremy liked to take charge of the filing cabinet and complete the register. To understand the whole system participants needed to know and have experienced both roles. We had swapped roles during planning sessions before we opened the Audio Library to give us some idea of how to explain to new members the system of listening to recordings before borrowing them. This was another aspect of reciprocal learning that they found challenging.

The two adults who naturally applied a reciprocal learning approach when they worked with students or other adults were the Senior Librarian and my mathematical friend who was my confidante throughout the study. Jaworski and Watson (1994) discuss the benefits of having a 'critical friend'. My friend had been a mentor for me in my previous academic studies and was always ready to listen and talk about the ups and downs that I was experiencing in this research. I had hoped that, as a researcher, I could fulfil a similar role for some of the adults in schools but, "as well as a degree of trust and confidence between those involved this may depend on some equality of power within the relationship" (ibid, p.128).



I did not encounter this problem with my friend but I was aware that this was a limiting factor in schools in which my role as a visiting researcher did not seem to be regarded as an asset. It was a great advantage having CHAMPE re-located in the main school library. Stephen, Jeremy and many other students could observe and benefit from reciprocal learning in practice by listening to how the Senior Librarian interacted with students borrowing books. It was normal practice in this environment but what was missing were explicit explanations about why this was happening so that others could implement this approach and extend it into other fields including mathematics. If individuals do not understand the concept of reciprocal learning, how to apply it in practice and acknowledge implications for themselves and others, there is little chance of its full potential being exploited.

Students who took the initiative to run CHAMPE and implement changes discovered that making decisions that affected many others was a complicated process. Like those of us who had contributed to the study for sometime, they required reminders that they had to continue to be learners although they had been elevated to roles of leaders. Some were unable to balance being proactive with acceptance of alternatives in interactions and finding that in reality there never is complete freedom of choice.

Observing and discussing with students when to stand back and resist giving support was enlightening for all of us. The CHAMPE assistants were upset by resentment from other students who required guidance but also wanted to be allowed to exercise control over their own learning. Reciprocal learning depended on participants understanding and applying the principle that in

collaborative communication and action they could be more knowledgeable, skilful and experienced in one domain but they needed to recognise and be prepared to be learners from these same individuals in other areas of learning. The art of mutual support was to provide struts for frameworks built on observing interactions and listening responsively to feedback but always to be aware of when and how to remove struts no longer needed. Individuals who had been members of CHAMPE and then took over as administrators and assistants found the most challenging aspect of the process was "dismantling the scaffold as the learning is seen to be taking place and the responsibility for it is increasingly shared with the learner" (Hewett and Nind 1998, p.294).

Teresa and her friend Vivienne took over, from Stephen and Jeremy, as assistants for CHAMPE and ran the Club/Library. Stephen continued to take charge during practical sessions in his role as a Senior Assistant for CHAMPE and as part of his responsibilities in training to be appointed a School Library prefect. The Senior Librarian and I met regularly with these students to decide on additional topics to record and ways to improve organisation and use of audio recordings. I was making preparations for the school to take over responsibility for CHAMPE. I was due to finish fieldwork and the two-year funding for the project had ended. The future organisation of the Club/Library would continue to follow procedures that the librarian had established for book borrowers. Audiotapes were checked in and out on the computer and certificates and merit marks were awarded for personal and outstanding dedication and action demonstrated by students. The Senior Librarian and I decided which students deserved awards and worded the announcement to be read out when certificates were

presented at a Year assembly. Weekly discussions were arranged but any of us could request an interim meeting.

Teresa's confidence and willingness to criticise both people and organisation of the audio library contrasted sharply with Vivienne's hesitancy to be critical.

Gradually Teresa began to make more constructive, creative suggestions concerning publicising CHAMPE and Vivienne volunteered her views without being prompted. The testing time came when they put their ideas into action. When this happened roles were reversed. Vivienne took the leading role proving reliable and able to take responsibility. Vivienne and Teresa did not have the determination to complete assignments necessary to gain the second certificate. It became as much a test of strength of commitment and character as mathematical ability. They invited their friends and younger students they knew to come along and find out for themselves whether they liked 'listening' as well as looking when revising or practicing topics and having a chance to check answers and strategies for themselves. With the strong support and proactive interest from the Senior Librarian this combination proved successful in the short term but for Teresa and Vivienne this was a case of learning from experience. Vivienne was trying to cope with bullying within the school at this stage. Her experiences endorsed the ones reported from the KWESI project in Birmingham), although this focused on Black Caribbean boys that, "peer mentoring and counselling approaches are perceived by pupils as highly beneficial in helping them to cope with and to counter bullying" (Mallon 2000, p.209). Friendships were fickle and changed frequently. Their ideas to encourage students to borrow recordings had not been as successful as they hoped and no adult within the school had agreed to take over my

role. A different way of inviting students to attend the Audio Library needed to be decided and possible administration changes made.

Daniel, who was in Year 9, offered to help with technology for CHAMPE and his idea of creating a website for CHAMPE came at a moment when interest and enthusiasm for the Club/Library needed reviving (Appendix 7c). He did much of the work at home, consulting people at a Professional Development Centre to increase his knowledge and skills to create a website intended for the intranet. The MRO who had supported CHAMPE since its inception supported Daniel in this venture. Daniel's programming ability and commitment to succeed in tasks he undertook were impressive. He was interested in the origins of the research that had begun by finding ways for young people with little or no sight to access print information in mathematics. He had many imaginative ideas for producing a website. He discovered a method to transfer sound from the audiotapes to accompany visual displays so that users with visual difficulties could access the website. He commented on how the opportunity to contribute to research had extended his own learning and was interested in sharing the knowledge and skills he had acquired with younger students. This was an example of a student motivated without external incentives to exceed his own achievements. He had taken the initiative and chosen to make a contribution to the research.

Daniel and I needed to analyse our own abilities that we took for granted in order to communicate with each other. Our strengths and abilities were very different. I asked for simpler explanations when I found his descriptions and explanations were incomprehensible or his speech was so fast that I could either not hear what he was saying

or he was overloading me with information that was irrelevant to the task we were attempting. He was determined to develop his communication and interpersonal skills so that he could train others to take over his work when he began his GCSE courses. An integral aim in the development of a reciprocal learning approach was, in common with other similar pedagogical ventures, "enabling people to be the best communicators and social interactors that they can" (Hewett and Nind 1998, pp.8-9). Daniel's determination demonstrated that "to be effective communicators we have to want to communicate" (ibid, p.3) but motivation alone was not enough. The most challenging aspect of forming reciprocal learning relationships for him was to convey his thoughts and ideas to others, including me, in language that we could understand and explain why and how particular actions were required.

I learnt about programming and the advantages and disadvantages of higher forms of technology such as recording onto CDs, DVDs and finding out how more advanced facilities on computers and in audio technology could assist use and production of the audio materials. Daniel found it difficult to contend with my lack of knowledge of technology and its terminology. He was accustomed to conversing at high speed with people who were familiar with abbreviated terms and computer jargon. He succeeded in producing interactive web pages with sound transferred from the original tapes that accompanied visual displays on screen. The more demanding task for him was to communicate his discoveries and progress verbally and in writing when we sought advice about applying for copyright or a patent for the website. On reflection, I realised my feelings of failure and doubts about my ability ever to manage to communicate in

language that was natural for computer experts were similar to feelings of many students who were striving to converse in a language that mathematicians expected them to understand. A measure of success for Daniel was that by the end of the year his achievement not only impressed visitors to the school who specialised in this field of study but he also managed to explain the system verbally and in writing in language that I could understand. He suggested that the introduction to his programme should include reference to the fact that this was 'research'. I asked him for his interpretation of 'research', what had he done first of all when he embarked on exploring possibilities for this website, his reply was: *"I did it by trial and error, I know that's the wrong way round"*. We discussed what he had said. When I reflected on how I started investigating use of audio materials, I realised that I had also used practical exploratory ways to unravel interpretations of the meaning of 'inclusiveness' and more recently 'reciprocal learning'.

## Reflections on reciprocal learning

Suggesting developing reciprocal learning relationships, between individuals at all levels in education, implies pedagogy that challenges the existing hierarchy of authority in classrooms and an assumption of how knowledge should be transmitted. I have gained more insight into the potential value of this approach, as I re-examined data collected in this study. Findings seem to indicate that reciprocal learning could benefit both students and adults when principles were applied with understanding and sensitivity. Conveying to others, in writing, my thoughts and experiences that at the time were exciting and enlightening continues to be a challenge for me. I do not believe that there is a *right*

or *wrong* "way round", theory and practice are interdependent and inseparable, and neither can be ignored. To develop learning, in-depth research is required in both aspects employing each to extend and support the other when necessary. For Daniel I felt this was a moment of revelation. It was a significant move forwards in developing the reciprocal learning relationship that had become well established between us and included the Senior Librarian and MRO as well as other students who had taken over running the Audio Library when Stephen was appointed as a prefect. I wish that I had made this discovery, when I was aged fourteen! At this stage major staff changes in management and the mathematics sections were in progress, including the departure of the headteacher, who had supported the study from the start. I had reached the hand-over point, agreed with her, when I introduced the research into School 5. Responsibility for the future of CHAMPE and decision-making for further changes and improvements to production and use of audio materials rested with the school.

## Chapter 6: Conclusion

### Introduction

In this conclusion to this thesis I examine to what extent the study has made a contribution to answering the overarching question posed in Chapter 1: "what part might audio recordings play in facilitating inclusiveness in mathematics in mainstream classes?" I have interlinked practice and theory throughout this study and therefore, in this final chapter, I continue to quote from theoretical sources to substantiate or challenge conclusions that I make now that the research has ended. In the first section, I return to issues raised in

Chapter 1 concerning how I got to know participants' existing and ongoing beliefs, interests, ideas, aspirations, motivations, knowledge, skills and past experiences related to the pedagogy of mathematics and conditions under which students were expected to learn. I question whether I valued difference and encouraged others to do so and improved students' chances of taking an active full part in all mathematical activities alongside their peers. I reflect on ways that I found of opening up opportunities for individuals to experience active participation in the field of mathematics, maintain an interest and enjoyment in this curricular subject, as well as progressing academically. With the benefit of hindsight I question again why inclusiveness was so elusive in this study and many adults were not persuaded that excluding students from classrooms' was neither necessary nor desirable. I analyse outcomes to decide how it could be possible in similar situations to ensure that students' resources are tapped to their full range and depth and that students are enabled to take proactive roles in relationships, dialogues and events.

In the second section I offer a critique of the research design and methods. I note links and commonalities that were evident between key incidents identified during data collection. I describe how the degree of trustworthiness of findings was assessed and how findings were used to make changes. I recall instances that demonstrated the need for flexibility and adaptation of roles and risks taken related to the central themes and issues that emerged. I discuss the limitations of the research due to my lack of influence as an outside researcher, use and misuse of power and inappropriate resources. I reconsider how I faced the challenge of opening opportunities for



students to utilise, as fully as possible, their abilities and openly express their ideas and feeling in mathematics and other fields of learning associated with this research. Finally I focus on what constituted the two-way learning approach termed as reciprocal learning, its importance and implications in the study and for the future and the value of applying a reflective approach before, during and after practice. I consider how others could take this research forwards by further investigation and development of the emergent process of reciprocal learning. I reflect on methodological principles that were adopted to establish long-standing reciprocal learning relationships and applied to find out if these assisted in achieving the aim of improving pedagogy in schools by uncovering the ways in which "explicit knowledge and implicit 'know how' reason and intuition are braided together" (Atkinson et al 2000, p.3). I argue that the process of reciprocal learning could become a recognised component in the endeavours to increase inclusiveness in mathematics education.

## **Contributions of the study to existing knowledge**

Willingness of participants to form reciprocal relationships and take part in activities seemed to depend on conditions that prevailed in particular situations. Derek and Stephen were two of the students who demonstrated that it was a realistic expectation for young people to develop inquiring minds, be critical without confrontation and take an equal or leading role in learning relationships with adults. Academic progress was noticeable when this happened. Part of the contribution that this study could make in facilitating

inclusiveness is to draw attention to how formation and development of reciprocal learning relationships can encourage, enable and improve collaborative communication and action across the generations and status levels in mathematics education. Stories of learning from and with participants told in Chapters 4 and 5 were selected on the basis of the length of time that students were involved in the study and their contributions to its purpose. Derek and Stephen contributed for over a year. I encouraged questions and criticism to keep the way open for change and improvement.

The conditions of openness and flexibility were vitally important for communication to be mutually productive. Introducing the audio process added an additional dimension to learning mathematics for many students. My hope had been that adults would also benefit from this innovative approach but this happened only in a few cases. The audio process provided a means to heighten motivation and a reason for forming relationships founded on trust. Constructive criticism of their own and others' ideas for improving the quality of the audio recordings and their use led to individuals realising that their own strengths and interests were of importance. Students discovered that they could influence decision-making even if suggestions made were not directly related to mathematics. This aspect of the study would be worth replicating for other students in their first three years of mathematics in secondary education. It might help ease transfer from primary to secondary mathematics education. It can come as shock to students when they are assigned to bottom sets or withdrawn from mathematics lessons as soon as they enter secondary schools. It does not seem surprising that they think of themselves as failures.

Findings from analysis of data collected in five schools over a period of three years indicate that use of the audio process provided insight, initially, into how students with little or no sight can take an active participatory role in mathematics education in mainstream schools and, eventually, how others experiencing difficulties accessing information could be helped by using audio recorded materials. The proviso was that adequate and appropriate resources, including time and support, must be made available when and where required. This claim is based mainly on students' stories, their voices and corroboration from adults who worked with them. The audio process made a contribution to the research by opening opportunity and encouraging even the most vulnerable students to speak. In preceding chapters their words have been quoted. The extent to which individuals felt that participation in mathematics had improved for them was one way of judging the contribution that the study had made. I was surprised by the number of students who had been willing to invest their time to contribute to the research.

There was no one right type of audio hardware or software. The most appropriate items and recordings were ones that enabled students to participate in all mathematical activities by means of the medium that they preferred. Adopting this approach reassured individuals that their differences were regarded as assets to learning not as disadvantages. It was not merely a matter of tolerating or paying lip service to uniqueness. This aspect of the audio process appeared to lessen the students' fear of failing and being wrong.

Applying what has been learnt from this study could make a more general contribution by providing insight into how

learning from each other can benefit all participants under certain conditions, if those involved play an active, constructive role in the process as explained in Chapter 5. Consciously applying this approach in practice provided a different epistemology of practice that had implications for all contributors. The dilemma was how to give a clearly articulated conceptualisation of reciprocal learning, after a relatively short period of time, without prescribing procedures and principles for others to follow unquestioningly that may make people feel threatened and dis-empowered. Frameworks to help guide thinking and practice are still at the piloting stage. I have only begun probing below the surface in order to understand which elements are most influential in determining the permanence of reciprocal learning relationships formed.

In this account, I have described negative outcomes in detail to stress that my claim that no ready-made solutions or fail-safe methods can be stated for enhancing or extending inclusiveness for students in mainstream classrooms. It is improbable that attempts to replicate methodological approaches applied and conditions created in this study would lead to the same outcomes for others in a different environment or that undesirable outcomes could be avoided. One of the most important contributions of this thesis to knowledge that already exists may be in its role as a discussion document. Linking practice with theories that have evolved could inspire more innovative thoughts and new ideas. Individuals would have to be prepared to risk taking an active role in forming and continuing to develop reciprocal learning relationships to understand the practical implications of this approach.

## *My learning*

Making my priorities, interests and intentions explicit from the start has been one precautionary measure taken to prevent preconceptions and assumptions dominating my reasoning and rationale during decision-making and action. My ability to think critically about educational processes and work collaboratively with others has developed in a way that I had never contemplated when I began this research. Planning and undertaking the study has opened up aspects of education about which I had little previous knowledge and given me deeper insight into the realms of learning. Unexpectedly a project that started as an investigation into how to enable students to access the mathematics curriculum more easily exposed unexpected sources of information and expertise, that seemly had been unexplored, under-used, under-researched and under-valued but had always existed, namely the resources that students themselves own. Ainscow (1999, p.4) in answering the question "what kinds of practice might help teachers to 'reach' out to all members of the class?" claims that the "two most important resources for learning are themselves and their pupils". I had been unaware of how my own learning could be extended through exposing and utilising this extensive resource.

Formulating questions to help students tackle mathematical activities and problems and audio record topics was similar to structuring a framework of questions to assist planning the next stage in the research. Examples were looking for more appropriate strategies; finding ways to surmount barriers that at first seemed to totally block the way forward and justifying choice of what to do and how to do it. Learning from this experience resembled findings

described by Watson et al (1998, p.23), "our intention to develop questions to help students learn, think and communicate mathematics led to a framework which we could use to *help ourselves* think about structuring our teaching". The students' ability to contribute to discussions, make judgements and assist others are only a few of the invaluable assets that they demonstrated at different times, that went far beyond the maturity and capabilities that I had anticipated from young people under the age of fifteen. They became, in all senses of the description, co-researchers.

I learned much from incidents that I had regarded as signs of failures but subsequently appreciated because they prepared me for eventualities that I had not foreseen would occur. I also gained wider and deeper understanding of how learning can be adversely affected through mishandling power, and undermining words can ultimately destroy all efforts to form relationships and improve situations. I realised how making thoughts and feelings explicit can be helpful to us all and that this is a crucial part of the learning process. The prospect of entering into reciprocal learning relationships with students may seem a risky and unnecessary venture. Taking risks, releasing control and questioning long held, well-established, educational and personal beliefs are demanding tasks. Claxton (1984, p.127) claims that, "when the risk is too great, we feel fear, and this is the signal to escape from the threat, to destroy it, or, if all else fails ignore it. This is not learning." There were many examples of trying to escape and ignore threats that existed to increasing inclusiveness for students but rarely efforts to try to remove causes. I was part of this majority group until I was spurred into action by negative outcomes for students that were, inevitably, the

result of not making criticisms explicit and avoiding taking any action. Even more disconcerting was the mismatch between words and action that may have resulted because individuals were desperate to avoid facing more challenges. It was difficult to trust someone whose words were invariably not implemented through deeds.

My learning was extended and deepened by further analysis of what did not happen or was not said and why. As Mercer (1995, p.2) concludes, "the process of sharing knowledge and developing understanding often seems to go awry. But the failures are as important for our understanding as the successes." I would argue that it is worthwhile exploring, in depth, an approach that can offer a way of tapping the invaluable resources for learning that students unquestionably possess but which are likely to remain dormant, unless consciously and sensitively utilised. The question became, 'can we teach effectively without reciprocal learning?' Endeavouring to answer this question requires examining existing mathematical pedagogy and considering implications for its future if reciprocal learning is accepted as an essential element in both teaching and learning.

Obsession with self-analysis could have detracted thoughts away from the focus and purpose of the research although it was important to keep questioning how my interpretations and reactions may have been influenced by my personal ideology, previous experience and philosophy. To avoid an inward-looking approach I concentrated with such intensity on providing access to print that I found I was ignoring and not being sufficiently critical of external variables. My experiences in this study support the observation that "a new educational experience can emerge from the least expected circumstances" (Malaguzzi

1998, p.57). It was the surprise incident and the unexpected comment that was often most significant in data collected during practical sessions.

At first I had been marginally more knowledgeable and experienced about use of audio hardware and making audio recordings than reciprocators but developing these skills was an interdependent process. We all needed to keep our speaking and listening skills and application under constant review, taking into account with whom we were communicating and extraneous factors that may be affecting our interaction.

Reciprocal learning relationships formed were not static. They changed and developed over time(See Tables 5.2. and 5.3). I decreased my intervention, gradually, as soon as individuals knew the rudiments of the audio process that were relevant for them. I also learnt to sense when struts needed to be replaced or learners required additional or alternative styles of support. In the final year of fieldwork opportunity to experience reciprocal learning, intended to increase inclusiveness in the CHAMPE Club/Library, was opened on a first-come, first-membership basis. The Main School Library provided a supportive environment in which reciprocal learning could flourish. This unplanned positive outcome of the study suggested a hypothesis for a further research project. What extracurricular provision is currently available in settings like a school library for students whose present experiences of inclusiveness, in mathematics education, in classrooms is severely restricted? Could opportunity be opened, like a library, to all students to take part in purposeful activities intended, not only for completing homework or reaching higher academic levels, but also for encouraging collaborative communication,



action and choice to enhance and extend enjoyment and interest in all aspects of mathematics?

One of the most important aspects of my learning from undertaking this research is summarised by Winter (2002b, pp. 36-37):

every time a colleague or a student or a client presents us with something new and surprising (in data), or a new possible interpretation pops into our head concerning some event or part of the data, we find new relevance in theories which we were 'aware of' beforehand, but which until this moment had not seemed significant ... we find ourselves remembering things we had forgotten we knew.

### **Innovative aspects of the study**

An unusual feature of this research was that a study motivated by a minority group being denied inclusiveness in mathematics education transformed thinking to focus on how to develop learning relationships between students and adults. The eventual outcome was a thesis about what might improve all students' chances of experiencing proactive participation in this core curricular subject. The study started as a technical exercise to find appropriate equipment and formats for audio presentation. An unexpected use of a technical approach was that it allowed students to openly criticise objects. This progressed, as Mohammed and Thomas first demonstrated to allowing feelings to be shown. In Chapter 5 the importance of individual induction sessions was discussed. These were helpful because general topics of conversation arose that provided rich information about backgrounds, beliefs and interests.

It was Derek who piloted the idea of relating to people at all levels in negotiations concerning the CHAMPE project. This method of gradually increasing complexity of content and the numbers of individuals contributing to discussions was a natural progression. Similarly, through necessity of working towards making improvements, we all had to develop better communication skills.

Another aspect that emerged as an integral part of the research was that data had to be collected and analysed to portray a representative picture of the ethos and external influences that existed in classrooms. I began to note reactions of students as they tried to fit into the system of learning mathematics that had been established in lessons. I was looking at inclusiveness from an individual's perspective rather than attempting to analyse whole situations from an administrative and organisational point of view. This decision was mainly due to lack of knowledge about people, policies and the environment when entering unfamiliar schools. I focused on inclusiveness rather than looking for deficits in people and situations. Ainscow (1999) cites others as well as himself who have written critically on the subject of the "so-called deficit model." He points out that:

even the most pedagogically advanced methods are likely to be ineffective in the hands of those who implicitly or explicitly subscribe to a belief system that regards some pupils, at best, as disadvantaged and in need of fixing, or, worse, as deficient, and therefore, beyond fixing.

(Ainscow 1999, p.7)

Total flexibility, like freedom of choice, was not a realistic possibility in an essentially social environment. Within the constraints of resources, that included time, I was able to give priority, through the CHAMPE project, to students who wanted to continue using the audio process after they had taken the Key Stage 3 national tests. After this point they could take over responsibility for their own learning by requesting particular topics to be audio recorded. Like Mohammed and Thomas, who opted to follow a distance learning programmes that I devised, they were in control of whether they continued or stopped working with me to complement their studies in GCSE mathematics courses.

Other crucial components in the development of reciprocal learning relationships were: the period of time that participants were willing and allowed to spend using their preferred learning style; timing of interventions to support learning relationships and obtain feedback (Chapter 5); whether creativity was encouraged in secondary mathematics education (Chapter 3); how listening, ausing and speaking skills were improved (Chapter 3); which adults were willing to learn from students' resources (Chapter 5); if joint ventures were undertaken to extend reciprocal learning relationships and inclusiveness beyond mathematics; if theories and practice from other areas and age groups in education were applied to mathematical learning in the first three years of secondary school. The innovative outcome was that a thesis emerged, as detailed in Chapter 5, that indicated that relationships of a reciprocal kind are a prerequisite to empower individuals to contribute to their own and others' learning about opening more opportunities for all students to experience inclusiveness in mathematics education. If adults showed

no genuine interest in getting to know students, reciprocal learning relationships tended not to survive or thrive. This endorses the claim made by Collins et al (2002, p.72) that it is essential that "time and energy are invested in finding out what the learner wants because it is necessary to engaging them in the learning process".

A particular strength of this research was that all communication and action in the study was data driven. Decision-making and implementing ideas depended on individuals who became involved, often, as a direct result of an unexpected or extraordinary set of circumstances. They were real people, in real situations who found themselves, as I did, immersed in an investigation that had not only enlightening moments, but also demanding and difficult phases during which it was tempting to abandon attempts to continue. Fortunately there were enough student contributors who managed to stay the course, for long enough, to make the research a worthwhile and informative experience.

## **Critique of research design and methods**

### **Data gathering and use**

From the pilot study I learned the need to select and record data to avoid being overwhelmed by the quantity collected, taking into consideration its relevance to the purpose of the whole study as well as at a particular moment in a specific context. I kept in mind Delamont's (1992, p.51) words of advice that "data is only as good as fieldnotes". Flexibility was essential.

I used critical/key incidents "as graphical tools" as suggested by Somekh (1995, p.342) to conceptualise and

identify characteristics of reciprocal learning and to ensure that my approach in practice was "developmental rather than merely a repetitive process" (Winter 1987, p.43). Writing narrative (See Chapter 1, p.13) accounts after practical sessions helped to expose my feelings, open different perspectives on interpretations of incidents and dialogue and provoke new thoughts.

To minimize bias and distortion of data I sought participants' views to affirm or disconfirm meanings that I had attributed to incidents. I avoided long lapses between involvement in practical sessions and writing descriptive reports, recalling Tripps' (1993) warning that this can result in distortion of interpretations. I gave equal or more credence to views of individuals who were reluctant to communicate as I did to those expressed by participants who always managed to make their voices heard. It was not until I asked students to think in terms of seeing and hearing the world from the viewpoint of adults, including myself, that I realised that I had underestimated their capability to offer constructive criticism and advice. Willingness to speak without reservation seemed to be influenced by the degree of trust established within relationships. Other variables ranged from who was taking part, where conversations took place and whether interchange of information was formal or informal.

Activities required to analyse data were similar to those required to find solutions to mathematical problems. We needed to be able to "explain, justify, verify, convince, refute, make changes and use questions flexibly" (Watson and Mason 1998, pp.37-39)

## Key Incidents

Incidents during the initial phases of the study that led to 'exceptional insights' (Woods 1998) occurred in situations when opportunity to use audio materials in classrooms was denied. Talking to students and adults in attempts to explain why this had happened gave insight into personal and organisational ideologies that I would otherwise have had no legitimate reasons to question. One of the most common events that affected students' ability to progress in mathematics was staff changes and absences. This unstable state of affairs resulted in my decision to stop visiting schools 3 and 4. Another incident that affected the course of the study was Mr D's departure from school 5. Uninformed adults took over his work and finally led to the majority of the students, only being permitted to continue to use audio recordings in the CHAMPE Club/Library.

It could not be assumed that merely collecting and analysing data to assess existing provision and practice would enhance or extend inclusiveness for students. An active, constructive response was required if barriers in classrooms were to be overcome or even partially removed. This had to be a two-way process. I acted as a sounding board for students and used them similarly to assist me to review and plan ahead to improve the audio process. We were co-researchers. This reciprocal arrangement was a great advantage in my role of an outside researcher. The main incentive for me to continue with the study, in spite of barriers that at times seemed insurmountable, was the words of students followed up by purposeful action.

One of my intentions in this thesis has been to share my thoughts and experiences with individuals who took part

and listen responsively to theirs. Claims to methodological soundness are made on the quality of data collected, how it was gathered and ideas that were inspired through analysis. Reasons for choice and application of methodological approaches were given in Chapter 2. New thoughts emerged from ongoing analysis. Re-examining findings with the benefit of hindsight has raised issues that require further research.

## **Contributions of Soft Systems Methodology**

Systems thinking described in Chapter 2 Part 1, in conjunction with constructing a framework of questions and root definitions guided decision-making and action. An example was Root Definition 2 formulated in Recess 1 (See Table 5.1), that draws attention to the need to communicate, clearly, the purpose of the research and for me to make my role explicit. Planning methods suggested in the SSM approach kept the focus firmly on the students who were the main beneficiaries and whose views were central to the research and constraints such as the NNS and school policies. It was imperative to identify and acknowledge people who exerted power to support or stop the study proceeding and environmental elements that had affected outcomes. Introductory talks to adults and students about the research differed but were not satisfactory until phase 5. I changed the content and presentation to ensure that all participants knew the purpose of the research and probable implications for themselves. Social issues could not be treated as secondary considerations. It was the type and quality of social interactions that affected the extent to which sharing knowledge, experience and other attributes was possible.

The one-to-one induction sessions were an ideal introduction to offering students opportunity to make choices and to begin to take control over their own learning. There was no right or wrong type of listening device or way of operating the recorder. The choice was theirs, limited only by the range of items available at that moment. I made full use of the students' willingness to talk and ask questions. A progression was decision-making with more individuals present and a greater variance of status levels and ages. SSM kept thoughts firmly focused on the aim of the study and aided attempts to reach a consensus, with the acknowledgement that this would not always be necessary or possible.

## **Contribution of action-research**

Applying action-research principles and implementing the cycle: plan→act to implement→observe→ reflect→ change to improve was relatively straightforward for introducing the audio process to individuals and improving production of audio materials, but unpredictable and complex in situations in schools due to variables in these essentially social environments.

Analysis of data collected indicated that not all students were being offered access to information provided in print in schools. Introducing audio-recordings into the first four schools had benefited a few individuals with visual impairment, but there was no prospect of increasing inclusiveness in mathematics due to rigid, long-established pedagogical systems operating in these environments. Students could not be held responsible for conditions that were adding to their accessing difficulties. The challenge was to help them find ways of working within settings over which they had little influence. This influenced my decision to adopt



action-research as the main methodological approach. It became apparent that the most effective way of students showing others the abilities that they evidently possessed was to demonstrate, in practice, their competence by taking agency over their own learning.

Distinguishing features of action research that proved to be particularly pertinent to this study were defined by Elliott (1997, p.25): "it involves practitioners in generating and testing action hypotheses about how to effect worthwhile educational change ... it focuses on changing practice to make it more consistent with the ideal". The ideal stated in Chapter 1 was to enhance and extend students' experiences and inclusiveness in mainstream mathematics education. The main hypothesis that emerged for attaining this pedagogical ideal was to form and develop reciprocal learning relationships. In Chapter 2 the ways in which frameworks and principles were used to guide planning, observation and reflection were described. A multi-method approach often led to re-thinking strategies as shown by the changes and additions to methodology that are shown in Tables 2.1 and 5.1.

Activities essential for producing audio recordings and providing feedback during and after use provided reasons for improving communication skills. Encouragement, not coercion, was given to communicate openly and freely. Nothing said was ignored. Sometimes I did not realise the significance of a casual remark until later when I was writing a narrative description or listening to an audio recording. This was the case when Caroline's SA voiced her concern about people in the staff room overhearing her efforts to script and record a mathematical topic and when Mohammed mentioned younger children in the home damaging equipment.

The nature of the audio and research process was in keeping with the principles of participatory and emancipatory action research as stated by Kemmis (1997, p.48): "participatory democracy involves substantial control by people over their own lives, and within that over their own work". It opened opportunities for students to be in control "rather than merely participate in the research process" (Walmsley 2001, p. 188). It was vital to take a critical stance when analysing data. Barriers to inclusiveness throughout the study convinced me that it was no exaggeration for Kincheloe (1995, p.74) to claim that, "methods and issues are always political in character". I was fortunate to be made aware of this early in the study. Having even a little knowledge about the history and policies, before introducing the study into school 5, was an advantage when trying to explain reasons for problems that arose over the following two years. Even with this knowledge I seldom managed "to uncover aspects of the dominant order which undermined efforts to pursue emancipatory goals" (Kincheloe 1995, p.74). A prime example was misplacement of students into sets that ultimately resulted in only Stephen fulfilling the conditions that allowed him to use audio recordings for the national tests in 2001.

## **Role changes and interchanges**

I constantly had to clarify my role to others and reconsider titles that were meaningful to students as well as adults. It had been the impromptu question that made me decide to adopt the title of audio teacher that seemed to satisfy everyone that I was not intent on trying to take over jobs. I maintained a flexible approach, remaining open to new and different ideas and meeting resistance as challenges that could be overcome.

I often had to remind others and myself of my role, to avoid misinterpretation of my intentions.

The type of relationships that participants formed with me depended on how they perceived my role and how I perceived theirs. Status and stereotyping affected how we communicated when feelings of superiority or inferiority were so entrenched that we could not change them.

When I attempted to form reciprocal relationships with adults who remained reluctant to take part in the study, I gained insight into what it could be like to be in a learning relationship that was one-way. I felt disillusioned and dis-empowered when information was withheld from me. In most instances I did not know if this was intentional or unintentional but I felt resentful and helpless. I could not dispel feelings of distrust that resulted from these failures in communication that affected all future interactions with these individuals. Having been on the receiving end of one-way communication, I was able to empathise with students' frustration when they knew that adults were not listening seriously to what they were saying or likely to take any action in response.

I learnt to sense which role to take and when and avoided adopting a prescriptive rigid approach. On the one hand uncertainty about my own role as an 'unknown outsider' introducing an innovative complementary idea for learning mathematics was a disadvantage, because no one had preliminary knowledge about me or if use of audio materials was a feasible proposition. On the other hand the starting point was the same for us all and we had no grounds for making assumptions or holding preconceived ideas about each other. Aspirations were a different matter we all had our hopes. I found that my willingness

to disclose my thoughts and make both my role and ideas explicit encouraged participants to communicate openly with me by participating in interactions as listener, responder, mutual learner and receiver of knowledge and experience from others. I eventually realised that it was inappropriate to discuss my reflections as if I was an insider practitioner teaching within a school, because part of my consciousness was always dedicated to working in research mode. Judgement of the quality and depth of data that I gathered through changing and interchanging roles with participants can be based on descriptions and voices that are woven into the narrative in this account. Reciprocal learning relationships could not be established unless all participants acquired sufficient sensitivity to know when to take the role of a receiver or giver in communication and action, as well as respecting and valuing individual differences.

## **Micropolitics**

Micropolitics was one of the most problematic facets of the study. The way in which power had been exerted in the first four schools had changed the course of the study. I had not intended to get drawn into any aspect of politics in schools but the nature of the research that I was undertaking meant that I needed to understand micropolitics that were adversely affecting inclusiveness. This entailed trying to get to know the micropolitics of the mathematics and the SEN departments and, towards the end of the study, of the School Library. Benjamin (2002, p.142) concludes that "the processes of intellectual subordination are located in discourses and discursive practices at systemic, institutional and interpersonal levels; indeed these discourses and discursive practice are the micropolitics of inclusive

education". Benjamin was an insider researcher and therefore could gain insight into the micropolitics of departments by attending staff meetings and listening to talk in the staffroom. As an outside researcher, I did not have this advantage.

This was one of the reasons why I adopted a predominantly critical action-research approach in school 5. I could not proceed without identifying why inclusiveness in mathematics in classrooms was not happening. Findings from analysis of data collected, with this purpose in mind, convinced me that constructive changes could be made by means of the audio process. Silence and no action would never result in change. I took the risk of making my concerns and criticisms explicit but also observed the BERA code of ethics. It required self-control to maintain a balance between total subservience and stepping over ethical boundaries, in an endeavour to bring about practical changes when inclusiveness was being denied to students.

Few adults, mainly support staff, had been interested in getting to know origins or thinking that underpinned the study. Most teachers seemed relieved when circumstances warranted requests for me to withdraw students using audio recordings from their lessons. When I was aware of micro-politics influencing opinions and actions of adults in schools, I found that the most demanding and difficult task in communicating with them was to question without confrontation and avoid making pronouncements and claims that could prevent us openly and honestly comparing our views. I heeded the warning that "mathematics education is practiced within a social and political domain, and egalitarian achievement practices may depend on greater acknowledgement of that fact" (Boaler 2000, p.12).

Seeming failure in four schools spurred me on to try alternative ways of continuing the study in spite of feelings that there were overwhelming odds against positive outcomes, concerning inclusiveness, being likely for students. It was during these low periods that I gained insight into the value of timely, empathetic support.

## Reflection

As I undertook the research in schools, periods of fieldwork were naturally interspersed with breaks for holidays. The organisation of mathematics lessons also determined when I could devote time to reflection for planning future fieldwork as well as analysing past incidents. A general pattern of reflection evolved that I eventually followed throughout the study.

Four main aspects of time related to reflection guided when and how I reflected. Firstly reflection-in-action (Schön 1983; 1987) when I was in direct communication with participants, reflection as soon as possible after action, re-reflection for planning purposes for the next practical phase and a final retrospective reflection period in which I could benefit from looking back over the whole research study.

My thinking was transformed as a result of experiences in the pilot study and schools 3 and 4. Failure to persuade adults that the audio process had potential for facilitating inclusiveness in mathematics for students with visual impairment caused me to stop and think again. Analysing what had happened during this period convinced me that methodological changes were necessary and that I had much to learn about conducting a long-term research project. I have come to the conclusion that my previous

experiences in education led me to make assumptions that were unrealistic given the present conditions under which mathematical education is practised in schools. To attempt to explain why the audio process was beneficial for some participants but not for others, I drew on knowledge I had acquired as a teacher, supporter and initiator of short term research projects (See Chapter 1, p.\*\*), combining this with learning from my more recent experiences as a researcher and theories and practical ideas from literature. Past participation in mathematics education was a resource against which I could test out my own and others ideas. Schön (1987, p.68) suggests that "it is our capacity to see unfamiliar situations as familiar ones, and to do in the former as we have in the latter, that enables us to bring our past experience to bear on the unique case."

In classrooms, I was often unaware that I had been reflecting-in-action because of the speed and variety of changes that were constantly in progress and the demands of observing, participating and recording data in addition to sensing when to intervene and change my role. After practical sessions, I questioned my intuitive responses and wrote accounts. Post-reflection enabled me to gain greater understanding of the significance of incidents that had occurred. My experiences were similar to Schön's in this respect:

to see *this* site as *that* one is not to subsume the first under a familiar category or rule. It is, rather, to see the unfamiliar one, without at first being able to say similar or different in respect to what ... it would be a mistake to attribute to the inquirer at the beginning of

such a process the articulated description that he achieves later on

(Schön 1987, pp.67-72)

Occasionally everyone's attention was drawn to an incident, as happened in one of Mr D's lessons, when wording of a question about equations caused confusion, but more usually it was a matter of making an instinctive response at a specific moment to a surprise event or comment.

Although I could identify with Schön's accounts of working with students who were studying design at tertiary education level, I was disturbed by constant reference to the distinction between the status and assumed superiority of the master or coach and the students. Difference in power position seemed to be equated with the value of input in relationships. This did not reflect findings from my study.

I kept in mind the details of the autobiographical accounts that I wrote when I began this research as reminders of why I may have reacted strongly or unexpectedly to certain events or dialogue. The aim and ways in which I undertook the research helped to ensure that I did not become too self-orientated because I was relying on feedback from participants. At the outset I felt that I had been too influenced by own beliefs that originated from my previous work in schools as a practitioner. As the study progressed I became more deeply involved in formulating trying out in practice action-hypotheses that arose from analysis of data collected. Theories of particular interest related to interchanging knowledge, skills and experiences. I acknowledged and took care to avoid the counterproductive



effect of thinking in terms of testing a hypothesis as a "mere self-fulfilling prophecy" (Schön 1987, p.74).

It was only through reflecting on action that I became aware that I had known-in-action and that my response had probably been influenced by a past incident. This was a developmental step in my learning. Sections in Chapters 4 and 5 give details of learning that I gained and retained for future occasions. Atkinson et al (2000), Hart (1995) and Nind, Simmons, Sheehy and Rix (2003), are among many who have expressed strong opinions on the pedagogical importance of intuition and spontaneity in educational contexts which paralleled my own experiences. For example an important part of the 'intensive interaction' method "is to retain the power of intuitive responding whilst supplementing it with the benefits of careful analysis to maximise the potential of the interaction" (Nind and Hewett 1994, p.10).

I kept in mind the purpose of each practical session as it related to the whole research study and was critical of my own responses. An instance when my reaction had been inappropriate was when I laughed at a poignant point in a conversation with Matthew about difficulties that had arisen when he was taking the national tests. This incident served as a constant reminder of how easily productive working relationships that are beginning to form can be destroyed.

In depth re-evaluation of methodological approaches during each recess raised theoretical issues to be explored further in the next phase. It was this aspect of the study that came to the fore, in phase 4, when Derek seized opportunities offered to exercise control over his own learning. He took a proactive role in decision-making and action. We tried out activities together that had

been identified as enabling and supportive of reciprocal learning relationships. Subsequently, I developed these with Stephen and other students to inform theory about how potential value of forming reciprocal learning relationships could be fully exploited in the future.

In the latter part of the study I was looking for reasons why reciprocal learning had proved productive and helpful for certain individuals in specific contexts and whether this could be replicated in another set of circumstances, with different people in order to facilitate inclusiveness for more students. Reflection was an ongoing activity throughout this research. It took over a year of fieldwork for me to experience reflection as described by Watson and Jaworski (1994, p.135) "one develops an inner mentor when the processes of reflection and action becomes unselfconscious, and occurs naturally as part of day-to-day practice". Keeping the features of reciprocal learning in mind, at all times, heightened my awareness of significant moments when learning roles were reversed. I was able to recall these incidents after sessions and search for possible reasons that included returning to reading about the experiences of others.

### **Interdependence between practice and theory**

Theories that I had researched during the planning phase related to audio technology and learning mathematics as explained in chapter 3. Originally I found that it could be more illuminating to try out my own ideas in practice first and then turn to theories and writings of others to endorse or challenge my findings. In the final phases I took a proactive role, concentrating on attempting to introduce change by means of action which was "considered and consciously theorised" (Carr and Kemmis 1986, p.192).

The action considered and theorised was development of reciprocal learning relationships.

Practice was informed by theory as indicated by references to the works and writings of others in varying fields of education including mathematics, technology and other curricular subjects in which accessing information presented in print as visual displays or text could be problematic. Implications for practice became evident from findings resulting from analysis of data, which in the later stages of the study related to the emerging concept of reciprocal learning. It was essential to look at how incidents that appeared separate were in fact related and how situations that seemed static were in fact changing or might be open to change. Originating from my belief that others cannot understand outcomes without knowing how data were collected and used, I have given detailed methodological descriptions and explanations. I was never certain that individuals had revealed their innermost thoughts in interviews. Reasons for being unable to explain inconsistencies and obtain relevant information were explained in Chapters 4 and 5. Students' experiences of inclusiveness were affected by how they perceived individuals with whom they were working and how others perceived them, as well as the appropriateness of audio materials produced. It did not depend on whether Derek was placed in a mixed ability or banded set or whether he was following an individual programme or working from books or worksheets in a class being taught as a whole group. The constant factor was Mr D who created an environment in which he was encouraged and enabled to use his preferred medium of audio recordings. This could have been the outcome for Linda, Thomas, Mohammed and many other students, if they had

been given similar opportunities of working in environments where use of audio recordings to complement learning was understood and valued by empathetic adults. Looking for links and trying to explain students' differing experiences made me realise the complex nature of mathematics education and that this cannot be separated from what is happening within the whole school or out of school.

The crucial components identified in situations where inclusiveness was in practice and productive seemed to revolve around the central issue of the quality of interpersonal working relationships formed between participants. The key activity in this process was communication. My thinking moved beyond the idea that a technical objective approach could provide a solution to exclusion to questioning why, given the same material circumstances, some students enjoyed and were enthusiastic about mathematics whilst others were struggling and in despair. Providing a complementary means of accessing information was only part of the solution. The stories and transcripts of conversations about how mathematical learning could be made more pleasurable and personally satisfying indicated that ability and inclination to communicate with individuals at all levels was a necessary starting point. Forming and developing reciprocal learning relationships became of paramount importance.

Writing this thesis to share my experiences and discoveries and retrace my steps through the phases and recesses of the study has helped clarify my thoughts. I have concluded that one of the foundation blocks that had to be firmly in place for reciprocal learning relationships to be of value to each contributor was a

commitment to match action with words. If this was not possible for any reason, comprehensible explanations had to be provided with opportunity and encouragement to question these. This was a task that I undertook when a promise made to students that they could use audio recordings for the national tests in 2001 was not fulfilled. It was evident that time had to be allowed for trust between participants to develop but this could quickly be destroyed if verbal assurances and promises were no more than words.

It was by avoiding a rigid restrictive, pre-conditioned response to people and events that the concept of reciprocal learning could thrive as a two-way process. I would suggest that the findings from this study indicate that the process of reciprocal learning has potential to increase inclusiveness in mathematics education not only for students with visual impairment but for everybody. This learning approach was of particular value to individuals who were feeling isolated and inept in mathematics and who had not ever had a chance to exert and enjoy taking control over their own learning. Adults who chose this path also required practical support as well as verbal encouragement.

I have found it illuminating to compare my immediate impressions of events and dialogue with interpretations that I make now with the benefit of hindsight and knowledge of how the whole study unfolded. It has been enlightening to read and listen, again, to data collected at the beginning of the study knowing what was to follow. How much easier the path would have been if I had been fore-armed with the invaluable learning that I have acquired over the years of undertaking this research. Coming up against barriers to inclusiveness and

experiencing collapse in reciprocal learning relationships that I had thought were well established would still have been traumatic but less of a surprise. I feel that I would have been more realistic about outcomes and certainly better informed to make contingency plans and talk about implications that may arise for contributors.

## Trustworthiness of findings

I have attempted to write a trustworthy account by presenting an audit trail of the study in terms of practical phases and reflective recesses (see Table 5.1). I chose to show progression chronologically in order to enable readers to follow my steps, gain insight into the thinking and processes that underpinned the research and understand how and why decisions were reached. I have made explicit methodological changes that were implemented to improve analysis of incidents and dialogue through the process of reflection, as described in previously in this chapter.

I depended to a great extent on feedback from contributors, whom I thought of as co-researchers, to judge if participants felt their experiences had been worthwhile and beneficial. I focussed on individuals in order to understand their lived experiences in mathematical education. Examples of transcripts of their voices were included in Chapters 3, 4 and 5. Differences in opinions and interpretations, as happened between Stephen and adults working with him, aided analysis by raising issues that I might otherwise have overlooked. I have recounted entire stories of the main students who took part in the study, without omitting their negative experiences or my own, in order to provide a

representative picture of this journey of discovery. I was surprised and heartened by their ability to offer constructive criticism and advice when we were working together to meet challenges.

To confirm or disconfirm interpretations, including my own, I discussed these with individuals who gave their interpretations of what they had observed in the same situation. Comparisons sometimes produced unexpected results. I would like to have been certain that students' interpretations were always given an equal chance to prevail in decision-making but this ideal was rarely achieved. An example of how raised hopes were soon disappointed was when students and adults were consulted about the re-organisation of mathematics sets but ultimately views were ignored by a person with sufficient power to ignore all views and make a decision that was irreversible and eventually closed opportunities for some students to experience inclusiveness in lessons.

I discovered the disadvantage, early in the study, of relying on one methodological approach to demonstrate that findings are sound and trustworthy. I found using a combination of principles from research methodologies in which collaborative communication, decision-making and action are central processes was a productive path to follow. This was one way of trying to ensure that no-one's point of view would automatically take precedence. The decision to consciously open opportunities to form reciprocal learning relationships between adults and exploit this process emerged through responding to issues that arose from practice. I had not analysed original data collected with this idea in mind but findings from re-analysis revealed features of reciprocal learning,

which had evidently resulted in positive outcomes for some participants and were therefore worth developing.

I mainly judged the contribution that this thesis might make to educational research in the future on its 'persuasiveness' (Winter 1989), in terms of replication in other settings. The issue will be whether other practitioners and researchers decide that not only will it be worth 'investing time' (Checkland 1999) to investigate further the process of establishing reciprocal learning relationships but also to consciously develop this further. I chose to introduce use and production of audio-recorded materials as a means of increasing inclusiveness but other means could be considered. People will need to discover for themselves if methodological principles applied in this research are appropriate to their own situations and individuals who take part.

## **Benefits of the study**

For me, the study was worthwhile because I was able to observe and be actively involved in problems that students were experiencing in practice and empathise with their feelings of rejection on occasions and elation when they made discoveries or overcame difficulties. I was conscious that my perception was not identical to theirs and there were many extraneous factors of which I was unaware.

In the following summary I give examples that, from my perspective, showed that the action research approach applied led to outcomes that indicated some students had benefited from participation in the study. The following list gives a sample of some of the positive outcomes for individuals. Many of the students benefited in ways that



they, nor I, foresaw at the outset. Sources of corroborative evidence are given in brackets:

- Thomas changed from being a maths phobic to a maths enthusiast, his speech and manual dexterity improved (Thomas, parents, childminder);
- Mohammed started to question strategies and suggest his own and enjoyed using audio (Mohammed chose to follow a distance-learning program, parents);
- Derek achieved his aim to exceed levels in mathematics predicted for him. He learned to lead without dogmatism or confrontation and valued the perspectives of others, including adults (Derek, report back from headteacher and Mr D, see Appendices 2d and 4c);
- Norma began to enjoy mathematics and gained enough confidence to give her views during a video recording (Norma, mathematics teacher, Head of Year);
- Stephen's confidence increased and he was able to voice his views, take responsibility and attain an acceptable level in the mathematics national tests (Stephen, parent, Senior Librarian);
- Daniel extended and applied his own technological knowledge to benefit other students' mathematical learning (Daniel, Media Resource Officer, LEA inspector, younger students).

How to judge the degree and quality of inclusiveness experienced is debatable. Recent advice given for inspecting secondary schools (effective from 2003) seems

to endorse my findings that certain characteristics identified as central to reciprocal learning warrant particular attention in all spheres of learning to enhance inclusiveness. Examples of recommended questions to ask are: "Do pupils form constructive relationships with others?" and "How seriously do staff take pupils' views?" It is responsive listening to the voices of the students who may not be experiencing inclusiveness in spite of claims to the contrary, followed up with action, that will determine if there is any improvement for them in the future.

## **Further research required**

A major contribution that further research could make to knowledge is to shed more light on conditions that predispose to inclusion in schools. This study suggests that students need to be encouraged and equipped to take over agency of their own learning. This evolved as a basic requirement for an inclusive approach. More long-term studies, in the early years of secondary education, are required to investigate how forming and developing reciprocal learning relationships could assist others who are dedicated to furthering the aim of increasing inclusiveness in mainstream mathematics classes.

More critical, constructive feedback is required from young people and adults who are sufficiently interested in the concept of reciprocal learning to risk experiencing it. Introducing audio-recorded materials to facilitate inclusiveness in mathematics education was one way of exposing the potential value of forming and developing reciprocal learning relationships between adults and students. Other innovative ideas could be tried out in practice in mathematics education and other

areas of life outside schools as well as within them. It is questionable whether the reactions and learning of others would have been similar to my own given the situations that arose, but as (Schön 1987, p.68) points out, " a unique case may be generalized to other cases, not by giving rise to general principles but by contributing to the practitioner's repertoire of exemplary themes from which, in subsequent cases of his practice, he may compose new variations".

My experiences in this research although limited by time, opportunity and numerous factors, that I had not anticipated, have opened up a new field of thoughts concerning what could lie ahead. I began to be aware of activities that facilitate formation of reciprocal learning relationships and started to recognise when and how to intervene to aid development but there is so much more to discover about how to interact with people at all levels.

The insight that I gained from being a proactive participant in reciprocal learning relationships has convinced me that applying this approach to mathematical learning in the early years in secondary school warrants further investigation. Interchanging roles and nurturing interdependence between students and adults, as described in the planning, launching and improvements implemented in CHAMPE was a worthwhile experience not only for me but also for many of the students who attended sessions. On the one hand, I am concerned that if others attempt to replicate this project without understanding the thinking and action that underpinned it, their expectations of immediate and positive outcomes could be disappointed because the whole process is still in its infancy. On the other hand, if no one continues to explore the

connectivity between reciprocal learning and inclusiveness and develops this idea further, students and adults will be left without a means that could enable them to enter each others' worlds and find out the invaluable learning that this entails. Also a chance of enhancing and extending inclusiveness in mathematics could be lost.

Mathematics education cannot be isolated from other aspects of education. Much can be learned from knowledge, ideas and styles of learning utilised in other curricular subjects. Whether the process of establishing reciprocal learning relationships to extend inclusiveness in mathematics education thrives or dies lies in the hands of policy makers and practitioners who are presently in schools and have the choice to make full use of their students' resources and resourcefulness or ignore these. Opportunities must be offered to students to experience this style of learning with appropriate support, understanding and commitment to the process of establishing reciprocal learning relationships.

Questions that raise issues for further research are: to what extent can more students, in other educational settings, be empowered to be proactive in reciprocal learning relationships with adults and experience inclusiveness as demonstrated in specific contexts in this study? Is it reasonable to expect individuals to participate in research studies introduced into schools by an outside researcher, working within a time limit, given the present teacher-student ratio in schools and additional demands on time to undertake an unending stream of new government initiatives? Meeting targets leaves little time for subject teachers to get to know students unless they prioritise this task as Mr D and a

few other adults managed to accomplish. CHAMPE played an important role in the study. Similar studies are necessary to find out, in a greater variety of settings and situations, if consciously developing reciprocal learning relationships can enhance and extend inclusiveness in mathematics education.

## Concluding thoughts

Paired reading in literacy and cross-age counselling were initiatives in progress in the schools in which I undertook this study but there was no evidence of this happening in mathematics education. Students' opinions about applying cross-age tutoring in the CHAMPE Club support Fitzgibbon's (1990, p.57) claims that, "the cross-age tutoring role will evoke in tutors strong feelings of responsibility, insights into the learning process, expressions of empathy with teachers, relief from boredom, and recognition that peer tutors may be able to assist learning". Combined with findings from this research it would seem that learning from each other in mathematics education warrants more extensive and in-depth investigation.

If I could have exceeded the time agreed for this study, I would have explored the idea of participants telling or writing their own stories and discussing these with larger audiences. It would have been a valuable learning experience for us all to hear about and compare incidents that others had interpreted as being significant to the process of inclusiveness. A group of people, including students, would be required who are sufficiently interested to run pilot studies on formation of reciprocal learning relationships for the purpose of drawing on strengths and interests across the

generations. Knowledge, experience and resources could be built up based on stories from practice that could be used as discussion documents by others. Characteristics that to date have been identified as essential if the reciprocal learning relationships are to benefit all parties are listed on Table 5.2, and developed as shown on Table 5.3. Developments in the future could be guided by analysing reasons for both positive and negative outcomes with environmental details and input from contributors described. I began to apply learning that I gained from forming and developing reciprocal learning relationships in this study to communicating and working collaboratively in other aspects of my life with professionals, family members and friends. This could be a research proposal for another thesis.

I am evidently not alone in expressing concern about the under-valued and under-developed art of listening. If more attention could be devoted to responsive listening and extraction skills, maybe more students' skills like Linda's would show general improvement. Adults either did not seem to consider listening was an important part of mathematics education, apart from when noise level was intolerable or students were reminded to listen when they gave incorrect answers to oral questions. Collins et al's (2002, p238) comment that, "superficial listening is commonplace" supports this view.

Knowing why adults rejected the idea of using audio materials in the classroom had, often, remained a mystery. This highlighted the issue that "to understand another's speech, it is not sufficient to understand his words—we must understand his thought. But even that is not enough—we must also know its motivation" (Vygotsky 1986, p.253). Reciprocal learning cannot lead to getting

to know personal motives if individuals are determined not to disclose their thoughts. Formation of reciprocal learning relationships opened opportunities for communication but this did not guarantee that what was said was intended to or actually did convey participants' real thoughts and feelings. It was only by comparing words with action that a representative picture of individuals and situations could be obtained. Hart (2003, p.231) concludes that "improvement does not have to be imposed on teachers, because the driving force comes from teachers' passions and sense of social justice; teacher desire and ability to make a difference are what makes teaching worthwhile". In this research this seemed to be the exception, with only a few teachers like Ms R, Mr D and Ms P being passionately committed to inclusiveness for students in mathematics. This could be explained by the fact that: I was an outsider introducing an innovation; most of the study was undertaken in secondary schools; the subject area was mathematics and teachers were battling to incorporate other innovatory ideas in their schedules. An aspect of this research in common with Hart's was that, "however committed and thoughtful teachers are, they cannot make a difference unless students themselves take up the invitations to learn that are extended to them" (Hart 2003, p. 224).

When external funding officially ended in 2001, I gradually handed over responsibility for running CHAMPE Club/Library to students and adults in school 5. I hoped that sometime in the near future reciprocal learning would be recognised as a means worth trying to attain the desirable state of affairs of all students being offered opportunity to experience inclusiveness in mathematics lessons. I left documented information that included guidelines for writing scripts, producing recordings and

requesting recording from the Narrating Service that was well established (see Appendices 6).

My original thinking has moved beyond the premise that providing easier access to print materials in mathematics would increase the probability that students would experience full participation in all mathematical activities:

our expectations of the child must be very flexible and varied. We must be able to be amazed and to enjoy – like the children often do. We must be able to catch the ball that the children throw to us, and toss it back to them in a way that makes the children want to continue the game with us, developing, perhaps, other games as we go along.

(Tiziana Filippini 1990)

I treasure the shared moments of amazement and enjoyment in which I have been privileged to participate with young people who took part in this study. The occasions when spontaneous reactions were expressed infected many of us with enthusiasm. I believe these times were instrumental in helping to release and expose emotions that were adversely affecting some students' ability to grasp and fully use opportunities offered. I was surprised and inspired by the unexpected ways in which opportunities opened up to develop reciprocal-learning and discovered that it was not only expectations of individuals that had to be flexible and varied but also expectations of what was likely to happen. I had to learn how "to catch the ball" that events and people threw at us, and "toss it back" in a way that convinced individuals, who chose to actively participate, that reciprocal learning was a worthwhile game to play and could lead to developing



existing thoughts and action, both in and beyond the field of mathematics.

"I found the research experience and the student's contributions remarkable ... I started by accommodating to restrictive conditions and learning to relinquish control" (Simmons 2003, p.245). I ended by exploring, "the emerging concept of reciprocal learning, both as a pedagogic relationship and as a method for practitioner research." (ibid, p.245). I leave it to others to judge if findings from this research are sufficiently trustworthy and convincing to warrant thinking in terms of implications for a model of learning and model of students as teachers as well as learners that needs to be adopted in schools. Thinking has to lead to action. Whether opportunities are offered to every student, to experience inclusiveness in mathematics education in all mainstream classrooms and if they are enabled to enjoy and benefit from these, will depend on how changes are implemented. As a result of discoveries made during this study, I suggest that there are implications for a school as a learning organisation.

Students had to be supported when they took the risk to form reciprocal learning relationships with adults. Forming and developing this type of working relationships with them that had resulted in us trusting each other enough to communicate our thoughts and feelings about our experiences of inclusiveness in mathematics. I would argue that this would be trustworthy evidence on which to base plans for the future. It requires all of us to not only listen to what is being said but also to respond with appropriate supportive action; in which we take a full part knowing that our contributions are valued and action will follow. The quote with which I end this

account is reminder to anyone contemplating taking this research further that they must be convinced that status or any other differences do not determine the degree to which contributions are valued and used, it is not titles or even words that matter but if and how words are put into action.

From lowest place when virtuous things proceed,  
The place is dignified by th' doer's deed"  
(Shakespeare 1998, p.100)

# GLOSSARY

CHAMPE: Community Helped Audio Mathematics for Participation and Equity. A Millennium funded, extracurricular, two-year project undertaken in school 5.

COTIS: The Confederation of Transcription Information Services. This organisation works with the RNIB and specialises in audio reproduction

GA: General Assistant, assists in the classroom but is not assigned to one student

IST: Individual Support Teacher. A teacher appointed to support a student in school for a number of hours, as specified on their special educational needs statement

Key incident: an event or dialogue that opened or closed opportunity and was significant to the research study (based on Tripp's (1993) 'critical incidents'.

LEA: Local Education Authority

LSA, SA or TA: Learning Support Assistant, Support Assistant or Teacher's Assistant is an assistant assigned to support a student, in school, for a number of hours allocated on the Statement of Special Educational Needs.

MRO: Media Resource Officer

NNP: National Numeracy Project

NNS: The National Numeracy Strategy

OU: the Open University

QCA: the Qualifications and Curriculum Authority. This was the examination board that organised and monitored the national curricular tests set in 2000 and 2001

RNIB: Royal National Institute for the Blind

SATs: Standard Assessment Tests. Key Stage 3 SATs are national tests undertaken by students in Year 9.

SENCO: Special Educational Needs Coordinator

SMILE: Schools Mathematics Individual Learning Environment

VI: Visual Impairment

# Appendices

## Appendix 1

### Students' stories and CHAMPE

#### *Pilot Study (April – July 1998)*

##### **Caroline**

(School 1, mixed primary, 320 students, South London; 30 in class; 12 lessons with Mr B and/or student on teaching practice; withdrawal from lessons when required)

I first met Caroline in a nursery class in School 1. She was three years old and had lost sight, suddenly, after an operation. She was in year 4, when I asked for her help with a pilot study. Ms E, her support assistant had obtained the Braille transcription qualification. The LEA provided equipment recommended on Caroline's Statement. There were was no spare money or time at home for help and interest in what Caroline was doing in school, except when crises occurred. Caroline was keen and able to learn mathematics. She used to talking openly to me about her thoughts and feelings but I had not worked with her in a classroom for over two years.

Caroline's mathematics teacher was Mr B for the first half term. During the second half of the term a student on teaching practice taught the class. I was asked to work with Caroline out of the classroom. I wrote a factual report, as requested by the school, about Caroline's involvement in the research (See Appendix 4a). I arranged induction sessions with Ms E, who managed, by the end of the term, to script and record audiotapes for Caroline. I made audio recordings during withdrawal

sessions with Caroline and Ms E and a video recording of Caroline learning alongside her peers.

### **Linda**

(School 2, mixed primary, 230 students South London; 30 in class; 15 lessons with Ms R; 7 lessons with teacher who would be teaching Linda maths in Year 6)

Linda managed her impaired vision well and won the respect of medical personnel in Guy's Hospital, who appreciated parental support given. She was registered 'partially sighted'. Linda's parents took an interest in the work she was doing in school. They wanted her to continue to attend a mainstream school. Their prime concern was that Linda should not be seen to be special or different when she transferred to secondary school.

Linda was in Year 5. She did not want to appear different or talk about the fact that she was depending on only one eye that had some useful vision. Linda was co-operative but initially unquestioning. She preferred to read text but if questions were long or her sight was poor on a particular day she found it helpful to listen to audio-recordings as she was looking at print copy. She did not appear to be at ease with adults but was sociable and talkative with students out of the classroom. Ms R, Linda's mathematics teacher, was interested and enthusiastic about the aim of the research and actively supported its introduction into her classroom.

I arranged formal interviews with the headteacher and SENCO but other data was collected informally. Ms was the support assistant assigned to Linda for mathematics. I wrote a report about Linda, as requested by the school (See Appendix 4b). Classes were re-grouped into ability sets ready for year 6. I never knew how a decision had

been reached that Linda would stop using audio recordings when she moved into a different teacher's class.

### *Schools 3 and 4 (September – December, 1998)*

#### **Mohammed (September-December 1998)**

(School 3, mixed Comprehensive 11-16, 960 students, North London; 27 in class; 3 x 1hr in lessons; 15 x 1hr withdrawn)

Mohammed was due to transfer to secondary school. I saw him in primary school where he was reported to be finding mathematics difficult. He was the eldest son in a family, where English was an additional language. He was registered as partially sighted but his mobility and language ability misled people about the seriousness of his visual impairment. He was apprehensive about moving into secondary education.

The VI adviser for the school had completed negotiations for Mohammed's transfer to a local comprehensive school. A meeting with Ms F(IST), Ms Q, the mathematics teacher for Mohammed's class, and the Special Educational Needs Coordinator (SENCO) was an encouraging beginning, but a series of unexpected events soon disrupted what had seemed to be a promising start.

When a series of cover teachers supervised the class, Mohammed lost continuity in following his individual mathematics programme and using audio recordings to assist him. He was unable to match the speed or level of work of his fully sighted peers. He became increasingly despondent and less communicative.

Due to circumstances within the school I had to withdraw Mohammed from lessons soon after the start of the new academic year. He chose to continue using audio recordings. I devised an individual distance-learning

programme that he could use at home. There was no prospect of Mohammed being able to use the audio process in mathematics lessons or for the school to be a suitable venue for a two-year funded, audio mathematics project.

### **Thomas**

(School 4, mixed primary, 230 students, South London; 30 in class; 3 lessons with Ms X. School stopped visits because temporary teachers taking class)

Thomas had no sight. He was in year 5. The headteacher asked me to communicate with the school through the Head of the LEA VI Service. Ms Y, an individual support assistant and Ms U, a general assistant shared the full time support that was provided for Thomas in mathematics. One of these supporters sat next to him in mathematics lessons. Thomas talked enthusiastically about his interests outside school but was reluctant to discuss mathematics until we got to know each other. Thomas was worried about getting answers 'wrong'.

Ms Y scripted and narrated her first recording on percentages just before she had a long period of absence. Ms U was not interested in taking an active part in the audio process. Due to a series of events, including the departure, early in the term, of Ms X the mathematics co-ordinator, who was Thomas' teacher, use of 'audio' was confined to times when he was in the home of his childminder. Temporary teachers were employed to teach Thomas' class mathematics. Finally, I was asked to stop visiting the school. Thomas wanted to continue using the audio process. I kept in contact with his parents. The VI adviser persuaded the LEA to purchase a set of audio equipment for Thomas. I devised an individual distance-learning programme for him. Thomas' school was not a suitable venue for the funded extracurricular project or



for developing a study intended to increase inclusiveness in mathematics education for Thomas.

### *School 5 (January 1999 – 2001)*

#### **Derek**

(School 5, mixed comprehensive, 1700 students, South London; 17 in Ms A's class, 2 x 1hr lessons for 3 weeks; 30 in Mr D's and Mr L's class, 2 or 3 x 1hr lessons weekly until took Key Stage 3 SATs)

The Head of the school in South London invited me to work for a trial period with Derek, who was in year 8, before deciding whether to agree to the research being introduced into classrooms and for the school to host a Millennium funded two-year project.

Derek was visually impaired and dyslexic according to his Statement. He was mathematically able but had difficulties reading and remembering, in the short term, text and numbers presented in print. Derek spoke passionately about his work in art and his hopes for a future career in this field. He did not mention his sight problem until we were talking about how students with no sight could learn mathematics. The type of working relationship formed in the first few weeks proved to be a strong foundation for developments in the future.

Derek's first mathematics teacher in Year 8, lowest set, was Ms A. Derek moved to Mr D's middle band set after a successful trial period. Mr D's classroom organisation took into consideration use of audio equipment and recordings and worked well even when lesson format changed to mainly whole class teaching. The opening up a world of mathematics for Derek was not a smooth, trouble-free operation but one he appreciated with hindsight. Opportunity for Derek to continue benefiting from use of

audio recordings in lessons was closed when he was placed in Mr L's set in September 1999. Mr D did not tell me details of negotiations that he had to undertake so that Derek and Norma, who was also have accessing difficulties, were transferred into his set in January 2000. Students took SATS in May 2000 and for the first time candidates, who fulfilled conditions stated, were given permission by the examining board to use audio recordings method, with the print copy, during the tests.

### **CHAMPE**

The headteacher, of school 5, agreed that the school would host a two-year Millennium funded audio mathematics project. The conditions were that: a host organisation had to be named and reports submitted at regular intervals; funding must not be used to subsidise LEA provision, it was to be an extra-curricular activity ; the theme was working across the generations. The extracurricular club was named CHAMPE (Community Helped Audio Mathematics for Participation and Equity). Examples of ideas to encourage active involvement and enjoyment are given in Appendix 6. Suggested improvements that most members supported were implemented as soon as possible, with the understanding that further changes would be needed and development would be ongoing

Mr D was appointed as the school coordinator. The school's Media Resource Officer supported CHAMPE from the start. The Senior Librarian played a major part in the development of CHAMPE to incorporate borrowing audio recordings. In the first year, Derek was the leading student protagonist of use of audio materials and one of the founder members of CHAMPE. Stephen took over Derek's role in the second year of the project.

The Club was founded to assist any student working towards Key Stage 3 national tests in mathematics but this did not preclude older students joining. Students could choose mathematical topics that they wanted to revise or reinforce, as well as which listening devices they preferred. They could work on their own or with each other. The focus was on changing and improving the whole process to link with topics recommended in the NNS and being taught in lessons. It was not intended as a substitute for teaching. Over fifty students attended CHAMPE, for a varying number of sessions, to try out using audio recordings.

### **John**

John was Derek's friend who assisted him to access print text and gained from the learning relationship through Derek's help with mathematics and technology. He took his lead from Derek. He was not motivated to learn and was reluctant to communicate his thoughts or feelings. He was always aware of what others thought of him. He opted to use audio recordings but their value to him was debatable.

### **Norma**

Norma used audiotapes in lessons and attended the CHAMPE Club. She opted to move into Mr D's set to prepare for SATs. She formed learning liaisons with several other students in this set. Norma liked detailed descriptions that helped her concentrate on significant features of visual displays that she tended to miss. Her increased confidence to voice her views became evident by the end of the academic year 2000. She was a sensitive listener and interested in learning. She had plans for a career that required counselling skills as well as academic study.

### **Alice**

Alice who came to the CHAMPE Club wanted to remain in Mr N's set because he was her form tutor. Alice was trying to cope with problems with reading print and communicating clearly when speaking. She had little understanding of the topics that she was expected to know about for the Key Stage 3 national tests. She liked to borrow audio-recordings to listen to at home.

### **Sarah**

Sarah came to the CHAMPE Club with her support assistant. She was one of the students in the school's Hearing Impairment Unit. The audio materials produced had not been specifically designed for students with hearing difficulties but attention had been given to quality and speed of speech on recordings. She was given the same choice as other members. After a few sessions she decided that she preferred to rely on her support person.

### **Stephen**

(Class sizes, 17 (Mr I) 26 (Mr N), 30 (Ms P); lessons 3 x 1hr weekly)

Stephen's mother confirmed my impression that Stephen felt he was failing in mathematics. He was blaming himself for all difficulties he was encountering. He was unable to see print displays in red and needed text and diagrams enlarged. Glasses did not provide the solution. He had no Statement, no individual support and there was no VI Adviser in the Borough. He was keen to learn but as well as relying on his peers for access he often required their help to tackle mathematical topics that he was assumed to have understood at an earlier stage.

I observed Stephen in Mr I's lessons near the end of the Spring term 2000, before deciding if audio-recordings

might be helpful for him. At the end of the term Stephen was assigned to Mr N's set. After nine lessons Mr N recommended that Stephen should be moved into a top set. For the remainder of the term his teacher was Ms P.

Ms P welcomed introduction of audio materials into her classroom and suggested other students who could benefit.

When sets were reorganised for Year 9 Stephen was placed, again, in Mr N's middle band set. Mr D left the school in July 2000. Stephen was the only student, out of ten selected at the beginning of the year, who was allowed to use audiotapes for the Key Stage 3 national tests in 2001. He gained the CHAMPE Mathematics Assistant's certificate and was appointed as a School Library prefect.

### **Jeremy**

Jeremy was one of Stephen's friends in Year 9. He assisted with the re-organisation and running of CHAMPE as a library. He was in a top maths set. He found writing solutions easier than oral explanations. He persevered obtained a Mathematics Certificate for assisting students up to level 4 in Key Stage 3. He was reliable and conscientious student and was appointed a school prefect.

### **Alistair and Jack**

Ms L, who worked with students categorised as dyslexic, suggested that Alistair and Jack would benefit from use of audio recordings. Both students attended CHAMPE and used audio means out of the classroom but without interest from adults in lessons, they chose to go on pursuing the same way of learning through print means alone, like their peers.

### **Jeremiah**

Jeremiah chose to borrow recordings to take home so that he could listen to them several times, which was the feature he liked. When he tried this in lessons his teacher described it as 'playing with the equipment'. He reverted to talking with other students and gave up the idea of persevering with the idea of trying to learn mathematics.

### **Alec**

Alec joined Mr I's class towards the end of the of the summer term. He found listening to the recordings helpful but he could not tolerate anything on or in his ears. He wanted to use audio for the national tests but he was one the nine students who had the offer withdrawn from the beginning of the term preceding the SATs.

### **Matthew**

Matthew asked me if he could try using an audio approach in the classroom. He liked to be the centre of attention and tended to disturb lessons but when he realised that his ideas were being taken seriously, he began to talk openly and honestly. He wanted to continue using the audio process but he was another student who was not given this opportunity.

### **Teresa and Vivienne**

The Senior Librarian suggested that CHAMPE should be run as a student initiative. Teresa and Vivienne asked if they could become CHAMPE assistants. Neither of them cited maths as their favourite subject but they shared an interest in making 'maths more fun and enjoyable'. They suggested more ideas than they actually put into practice.

### **Daniel**

Daniel asked if I wanted help with technology for CHAMPE. I accepted his offer. Daniel took on the responsibility with commitment and dedication. He showed determination to overcome every challenge that arose during the following months when development revolved around creating a CHAMPE website.



## Appendix 2

### Feedback

#### 2a FEEDBACK from STUDENTS

STUDENT VOICES: What do you think C.H.A.M.P.E. is all about?  
What do think is the point of the scheme?

Daniel: to teach maths to people who have some disability with their eyes or just need a boost in maths...a basic way of teaching for understanding maths...

Q: what would you say to encourage students to come to C.H.A.M.P.E.?

Stephen: If you're finding any of the subjects in maths are hard or anything we're there to help you...the tapes you can borrow are a great help...there are good explanations, you can rewind them and listen again and again until you can understand properly

Q: If you were going to talk to the maths teachers how would explain about C.H.A.M.P.E.?

Teresa: it's an opportunity to extend your maths levels...most jobs need a maths degree...

Vivienne: with tapes you get it to go into your head more and can remember them more...

Teresa: if you're reading and someone starts talking to you, you can just stop reading and look at them and by the time you get back to it you've forgotten what the first bit was about. If you're listening to it, if people speak to you can't hear them because of the ear phones...people can't say they hadn't heard it cos it's right up to their ears...it explains how you do the answer

Vivienne: you get explanations and descriptions....

C.H.A.M.P.E. Research Assistant.....  
 Topic/Place: value

Date: 8/1/01

1. Were you able to write the title without stopping the tape? ~~No~~ Yes
2. Any mistakes on the tape? Write down which question. Number... 10
3. Write the number of any question you needed to listen to again ... 4
4. Which speed did you use for listening? normal or slow or fast ... normal
5. Please tell us about any difficult words. none
6. What was the number of the last question you finished? .....
7. Give marks out of 10 for how useful you think this tape would be for other pupils. 0 1 2 3 4 5 6 7 8 9 10 (draw a circle round one number)
8. How could we improve this tape? O.K



## **2b CHANGES IMPLEMENTED**

1. Initially three tones were inserted for the start of sections, two tones for the beginning of a question and one tone for each part. Students found the pauses in speech resulting from tones being inserted slowed down their working even when they set the speed control to fast. From this feedback a decision was agreed to use one tone for questions and two tones for sections. Derek became an expert on pin pointing information on tapes through finding tones. He and other students disliked the RNIB GCSE tapes because no tone was inserted for each question and the narrator sounded 'bored' as there was little change of pitch in the voice.

2. A few students requested less description of diagrams like graphs and tables. This raised the issue of how to present information so that it was helpful for everyone including those interpreting tactile diagrams as they listened. It was this comment that convinced me that I should pass on the skills of production to people in the schools who knew the recipients rather than forming an external recording Service like the RNIB or RFBF. Adaptations could then be made for particular individuals who required more or less explanations or required information in a different language.

3. In my role as observer-participant I noted frequent occasions when teachers worked through the example in the textbook with the whole class and then gave the instruction to start the exercises on a given page. When writing scripts possibilities like this had to be taken into account. Page numbers of books were given out when recording material for lessons and positions of relevant diagrams briefly stated e.g. 'top left' or 'below the print'.

4. The students suggested shortening the introduction at the beginning of self-check recordings. They wanted to immediately know the topic and side of the tape, the number of sections and exercises and content, if help sheets, or apparatus like calculators were needed. In CHAMPE lunchtime sessions students sometimes had only about twenty minutes to work on a topic. Names of narrators and copyright acknowledgements were read at the end of each recording. Pearson Publishers accepted this arrangement. Other changes made to original presentation was to explain strategies and answers directly after each question instead of after every five questions. Feedback from listeners indicated that certain changes in the format and presentation of mathematics were needed to allow for differences between working in mainstream classrooms with large groups of students than with smaller groups in 'special' schools which were the listeners targeted by external Services.

5. As the research progressed less suggestions resulted in changes being made because ways of presenting information had been tried and tested in practice by other students and their opinions and experiences could be quoted to justify retaining certain ideas. For example repeating amounts twice, once as a complete number and a second time in digit form e.g. £6.73 six pounds seventy three pence, six, point, seven, three pounds. Repetition of numbers is the accepted procedure on aircraft to avoid errors being made and most students found this reassuring and reasonable.

## 2c A SUPPORT ASSISTANT'S NOTES

18.6.98

Use of speed control (blue) which can be pushed across to fff or Rew as necessary.

Check list for recording

Set the speed & pitch control (orange & blue) to 1

Set mic sense to low if in noisy surroundings

Set VSC switch to on.

Set volume to minimum (do short test of recording)

Side of recorder Set tape side to 1-2

Set tape speed on 'hi', place recorder on soft surface

Recording

press pause, press record use pause button to control recording

Count to 5000 ie 1000, 2000. till lead tape goes through.

Introduction to tape (1 division equal sharing Maths tape 1

To play back turn up volume. Press play

### Scripts

look at title of page and look at what pages is all about, Then relate any description of pictures to the content



## 2d A TEACHER'S PERSPECTIVE (Mr D July 2000)

### o REFLECTIONS AND BETTER UNDERSTANDING

After the cycle of a year's teaching I am in a better position to see a little of what Susan was aiming for and closer to understanding some of her objectives. It would have been impossible for her to outline these from the outset, as we were constantly reacting to various problems and barriers, and reassessing the best path to take. I feel that next year will be much easier for everybody concerned with the project.

### o BENEFITS

All tape users were identified as having big gaps in their mathematical understanding, which seemed to be getting larger, whereas they often appeared perfectly capable in other areas. They had a problem of accessibility. With a reader or individual tuition, barriers could be broken down, and problems understood. Audio tapes were a more realistic and cost effective option.

The project has helped those students involved to realise that barriers to learning can be overcome, and a good deal of success achieved. It has helped raise their self esteem and confidence to a tremendous degree, and for 2 students, curbed their disruptive behaviour, which was so obviously borne out of frustration.

This has helped me to take a fresh look at all the material that I use, and the style of teaching that I adopt, particularly with students who seem to be failing. I feel more confident about trying 'something new', and about others being present in the room whilst I am teaching.

There was some extra work involved initially, but very little once the tape users had managed to combine their needs with my way of teaching. It was really just a matter of developing a greater understanding of the needs of all of the students that I teach.

### o TEACHING STYLE, EXPECTATIONS & OUTCOMES

Originally, I thought that 3 students using audio tapes would not effect my teaching in any way, but I think that, inevitably, my behaviour changed. Greater preparation was needed, so that Susan had time to record the necessary tapes. More analysis was required, to evaluate the appropriateness of the material for the CHAMPE club members, and to reflect on its success or failings. Timing in lessons needed to be observed closely, so that there was always time to explain and reinforce 'key' points or issues orally. Progress monitored more closely than usual, looking at individual topics in order to assess which areas of maths needed reinforcing with extra help through CHAMPE. Finally, in an attempt to improve accessibility a greater variety of materials were used.

### o FUTURE

Many more students have been identified as having problems reading written materials. They have already started using tapes in the classroom, despite difficulties with the setting arrangements this year again. The 3 students who I taught this year, are very keen to carry on using tapes for their GCSE course, and are now only too aware of how this scheme has helped them develop, academically and emotionally.

A selection of tapes will be available for pupils to listen to, and to borrow from the school's library.

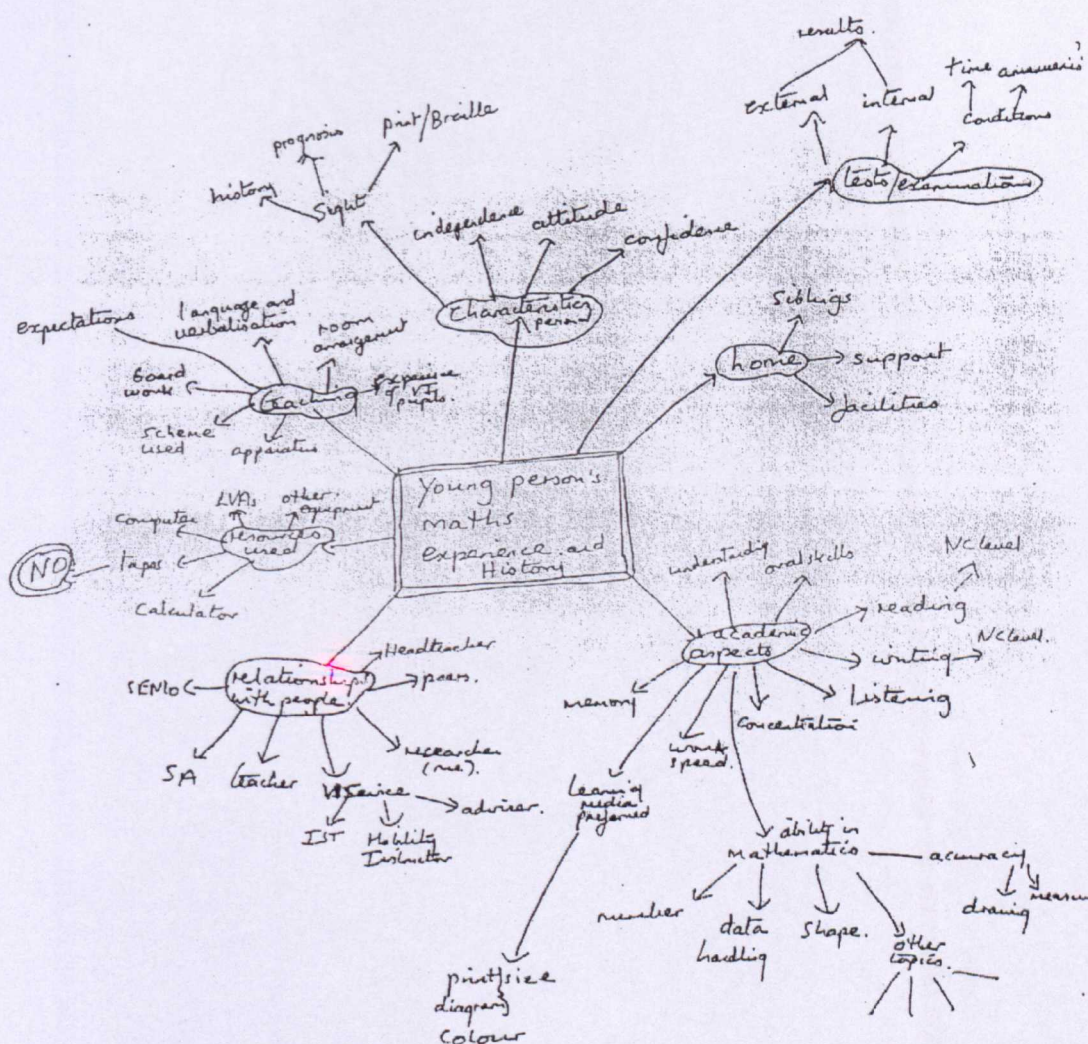
More staff will be involved in teaching students who have access to audio mathematics.



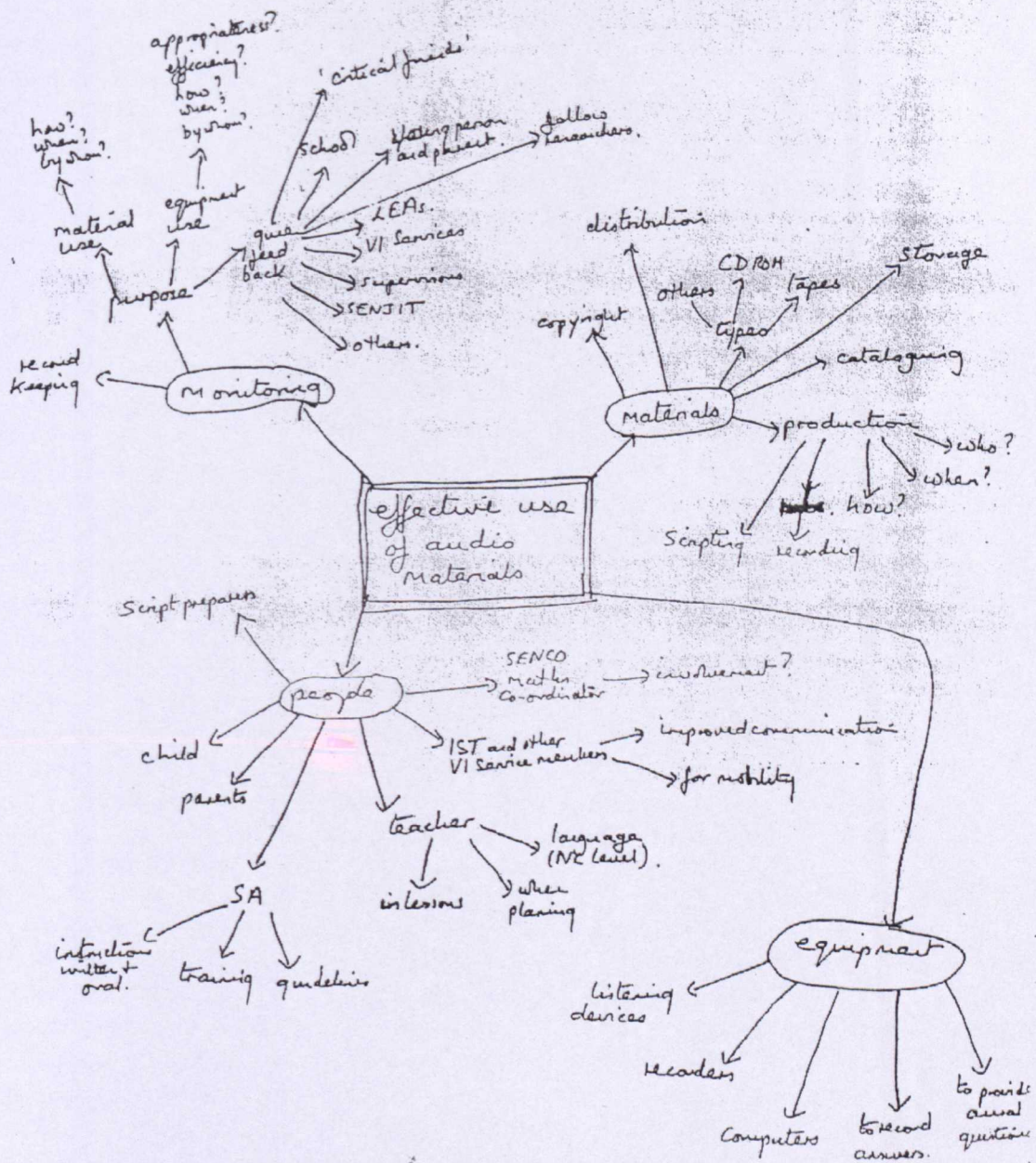
## Appendix 3

### Data

### 3a RICH PICTURES







### 3b QUESTIONS

Questions to guide a critical action-research approach and to assist communication

*What information will people need to know at the outset?* e.g. students to choose whether they want to continue to use audio materials; people in the school to gradually take over coordination of the audio process from me.

*How to explain the purpose of the study and my role?* To whom? When? How should I word explanations?;

*What do I need to know?* e.g. school staffing and policies, past/present mathematical schemes and departmental policies; which print materials students will need to access; how are they accessing print at present; which mathematical topics do they understand and find interesting.

*Arrangements to make?* e.g. timing and environment for introducing audio items and subsequent arrangements for working in classrooms and launching a funded audio mathematics club

*How to work collaboratively with adults and students?* Where and when can progress and concerns be discussed and decisions made through combining feedbacks?

*Which ethical issues must be respected?* e.g. confidentiality when audio recording conversations and mathematical explanations in classrooms; making contact with parents; distributing copies of written reports/accounts and keeping everyone informed

*Thoughts and action making my role explicit in personal records and practice?* e.g. How to put my skills and knowledge at the disposal of participants; how and when to intervene in events and dialogue; how to agree and disagree with contributors and arrive at decisions for implementing ideas in practice; acknowledging opinions, surprises and events that trigger memories from my own background and personal philosophy; surmising about how personal and organisational ideologies and histories may be affecting participants reactions and responses; deciding which incidents are critical, explaining why and noting feelings; how to accommodate to conditions in classrooms to understand reality from a students' perspective; how to respond with flexibility and keep focused on the purpose of the research; how to vary role (observer, observer-participant, participant-observer) according to circumstances including taking control when necessary?; how to use theory to inform practice and use learning from practice to inform theory; how to maintain a balance between accommodating and voicing criticism and taking action about conditions preventing students or adults fully participating in the investigation. *Further questions:* Which transformations might help students learning mathematics in similar environments? New insights gained from re-examining findings?



## 3c NOTES from LOGS and NOTEBOOKS

Listening quiz 2. - examples of why recorder + use of tape helps

(H) "Became a matter you have to stare a lot & give me little a headache that's coming down a bit so I can wear a bit less PRO-JW move" "you don't have to read a lot. you listen" 1998

At end of lesson as packing up I talked to (D) + (F) about change club instead of asking them to come to 10 & at lunch time - both seemed pleased + also gave them list of tapes that they would be able to borrow by end of term 'maybe have a set of tapes for revision for holidays but only borrow one at a time during term' liked this idea + both obviously relaxed - neither sure about giving up their Wednesday place to year 8 pupils. Then the remainder of the day by (D).  
 // 'Why can't we use tapes for Science. Listening really gets it into your head' 18.05.2000.

CT My role - Non-participant observer impression fully occupied with paperwork sitting at back of class, diag opp (SR) place.

(SR) still sitting 2nd desk in front row Jan R. not certainly [reflection should I intervene with seating??]

??? Check - was (SR) getting answers for V&D correct??? said did not want to come at lunch time (only said)

Class seating 25 pupils.

Board

M.B.

B B

G -

B B

- (me)

G G G G (SR) B → moved from back

G - B B B

B B - G G

B B B B B

11th Jan  
Thursday  
2001



## 3c (ii) NOTES from LOGS and NOTEBOOKS

**Aim:** (a) to build up a "rich picture" of the pupil's mathematical experience working in a mainstream classroom without, then with the use of audio tapes (b) following each observation session to analyse results to aid understanding and prepare for subsequent sessions i.e. use data to raise further questions and queries and improve methodology.

**Methodology:** (a) daily diary recording details of events observed (where? what? when? who?) own role, impressions, insights, feelings. (b) tables/diagrams/checklist to be used as appropriate (c) video/audio recordings if acceptable.

**SCHEDULE 1** (A is pupil with visual impairment and B is pupil selected for comparative study)

**Task list:**

**Week before lessons:** know content--look at text/diagrams to be presented to the pupil e.g. layout, print size, use of colour in original copy--predict and discuss own role with pupil, teacher, IST/LSA.

**Start of lessons:** position in classroom related to teacher/other pupils/IST or LSA, accessibility to essential requirements e.g. book/folder, apparatus, reference areas--adults present--explanations/instructions (language used?) given by teacher/IST or LSA and pupils A and B's response to these--study of pupil A and B's personal organisation of necessary equipment (machine/book, recording and/or drawing items) and time taken to start task.

**During lessons** for pupils A and B--use of table for checking mathematical activities, column headings: Task (cross referencing between question and recording answer, looking at diagram etc.), Frequency, Time, Topic, Grouping--diagram to indicate type and amount of interaction between the 2 pupils and teacher/pupils/IST or LSA e.g. intervention, requests for help or talk (general/specific to maths)--concentration (listening, distractions).

**End of lessons** for pupils A and B: how and by whom is work marked--how does pupil know comments and results--time for personal organisation to be ready for next event of the day.

**Throughout the lessons** for pupils A and B: notes on evidence indicating interest, motivation, enjoyment, satisfaction, self esteem, self confidence.

April 1998.



## Appendix 4

### Sample Reports about Students

#### 4a CAROLINE

Report on Research 13th May-30th June 1998

##### Summary

Preparation: agreement to undertake a pilot scheme in the school was received from: C., her mother, the acting Headteacher, Mathematics Co-ordinator, Classteacher, SSA and the Advisory/Support teacher (Visual Impairment Service).

Permission was obtained from CUP, the publishers of the Cambridge Primary Mathematics scheme, to reproduce and record on tape specified material for limited research purposes only. After consultation with the Classteacher selected pages were scripted before the start of the term e.g. Module 5 Book 1 Data Handling, Time, Angles-Book 2 Angles 2, Data 3. Preliminary recordings were made with an experienced mathematics teacher, who is interested in this research project. Copyright conditions were observed and acknowledgements included in recordings as requested.

##### Results

Due to a sequence of events in the school, the start of the research was delayed by two weeks and the textbooks for the Mathematics scheme were not used. It was essential to take into account C.'s reluctance to use the Handicassette recorder and headphones provided for her and not impose use of tapes just because of the research topic. After the initial observation to identify working methods and use of language, it was evident that C. should follow the same program as her peers. Topics were revised at speed in lessons, it was not the time to introduce new skills and working methods. After half term a student used worksheets with the class. The additional demand for work in advance was too much for the teacher preparing for the pilots SATs and the student. The content of the student's worksheets for topics other than pure number work (C.'s

Braille skills are good) was not suitable for recording on tape. The activities were practical or required little reading or cross referencing from questions to diagrams e.g. cutting out shapes, calculating angles, drawing shapes.

A decision was made not to pursue the idea of introducing use of tapes in the classroom. An alternative use identified was for homework, which C. likes and could have given her the chance to finish work, for which she needed more time in the lesson but C. does not have a tape recorder at home. Finally it was agreed that it would be better for the SSA to gradually introduce and develop the use of tapes for mathematics, when this became appropriate for C. and it was felt that she would benefit from an audio medium to complement or as an alternative to tactile work. Two practical training periods were organised to guide scripting and recording and then a final session with C. and her SSA on their own, so C. could try out different listening devices, use a prepared tape and give her comments.

##### Conclusion

The priorities for C. for next year will have to be, adjusting to working with a different teacher and IST and continuing to develop her Braille and touch-typing skills. Tapes for mathematics will be produced by the SSA, after consultation with the teacher, if and when considered appropriate. Basic equipment needed: a small recorder, a single earphone preferred by C., an adaptor for dual listening, batteries, a charger and C20 tapes. Contact Susan Simmons for advice or help and possible re-involvement, through the school.

\*\* Material to be prepared on tape, should be given to the SSA in advance to enable scripting and recording (a week ahead is advised, less may be possible occasionally) so the tape is ready for C. to use, when she needs it.



## 4b LINDA

Methodology

The following people were consulted: L, her mother, headteacher, SENCO, mathematics co-ordinator, classteacher and SSA. Before introducing use of tapes, observation was undertaken to identify the phraseology and mathematical terms used by the teacher and children for different topics. It was important to know the working methods in the classroom, when using the SMPG scheme. Individual support was undertaken to replace the SSA, when a tape available, was the one L needed to use e.g. Atholl Wood (T5 p. 111, p.112, p114) Cora's Computer (T5 p.107) Ship Ahoy! (W4 p.7, 8). Signs (T4 p.37)

Before the term started Heinemann publishers had given permission with specified conditions to allow reproduction of textbooks and associated materials to be recorded on tape for limited research purposes.

The material selected for scripting and recording depended on the teacher's curriculum plan for the term. Tapes made were: Shape and Handling Data—workbook 4, pathways and right angles p. 7,8, 10 and textbook 5, symmetry 2 lines(p. 96) grid references (p.107), bar graphs (111-114) and Number—textbook 4, division (p. 36-40). Two voices were used for some tapes, tone-indexing and sounds to pause the tape when necessary. Music and sound effects, relevant to content were included on two tapes.

As well as talking to participants during lessons and sometimes briefly before or after these, interviews were arranged and tape recorded with L (2 at beginning of lunch times), SSA (1 during music) and classteacher at the end of the pilot study (cover provided).

7th July a meeting with L's new classteacher was held (cover provided).

Summary

It was not possible for L. to use the Panasonic recorder, with which she was familiar, in class because there was not enough space on the table next to her tilting desk. She soon learnt how to operate the small Sony recorder and experimented with the different types of earphones and headphones. She was willing to state her preferences and enthusiastically responded to requests for feedback about the tapes and equipment. It was essential to listen carefully to the language used in lessons and incorporated this when giving explanations on tape. Audio recordings would make the process easier and this would not be a problem for this classteacher, who was most helpful and interested in the possible outcomes of the research. Because the SSA has worked with L. since individual support was

assigned for her, she was able to provide invaluable information about L's ability and things which can be difficult for her. On 30th June the SSA, successfully, recorded her first tape for mathematics, with tone indexing (division textbook 4 n.44).



#### 4c DEREK Report on mathematics support for Derek (Susan F. Simmons) 19.3.99

##### Support sessions:

14th Jan: introduced to Derek brief talk before the lesson, observation in class.

21st Jan: observation in class, Derek absent.

28th Jan. 4th Feb. 11th Feb. 25th Feb. 4th and 8th March, withdrawn from lessons, individual work, acquiring skills to operate the recorder (including tone-indexing), use tapes and the various types of resource materials.

11th and 18th March, SMP Module Tests 1 and 2 (recorded on tape for use with diagrams prepared) in class with the maths group, to which he has been assigned.

##### Issues related to information requested

Initially Derek was concerned about writing 'wrong' answers and not using the 'right' methods. Orally he discussed topics and indicated interest in the subject content, asking questions to clarify points and admitting when he did not know or understand terms and phrases. His written work was difficult to interpret, with alterations, crossed out digits and no clear separation of question numbers from working methods and answers. He seems to be gradually gaining more self confidence but he does need praise and encouragement and tasks at an appropriate level to challenge him but not threaten his still fragile belief, that he might be capable of succeeding in this area of learning. His concentration level seems to depend primarily on interest and the degree of success which he can achieve. His attention tends to become less focused when he has not asked for help but needs it. There have been no lapses of concentration during any of the sessions to date but this is a report based on 8 lessons (6 sessions, in a one to one working situation with no external distractions). Derek has returned the self-checking tapes loaned for work at home, given me some written answers completed in his own time and enlarged a set of drawings to help with my research.

The requirement of literacy skills has been minimal. Listening, memory and diagram reading skills are, at present, the main features of this audio learning method started with Derek. Obtaining and recording information has been dependent, predominantly, on use of maths operation signs and abbreviations. The most effective method for Darren to access the content of the SMP booklets and write answers for classwork and homework is only beginning to evolve and will need consultation with his maths and learning support teachers, as well as taking into account his own views.

##### Conclusion:

Audio tapes could help Derek to fulfil his potential in maths because:

- (a) His listening skills are good and he can often extract and comment on maths tasks even when he has heard information only once.
- (b) His learning motivation is high and he is willing to persevere to solve problems.
- (c) If he has understood the reason for correction or an alternative working method, he can often remember and apply advice given e.g. presentation of work and number rules or patterns which can shorten the time spent on tasks.
- (d) He has demonstrated ability to think and act creatively and logically on occasions to compensate for his evident short term memory difficulty e.g. 'table' facts.

**Recommendation:** Combined problem solving, with Derek and his maths and learning support teachers, to decide on the best methods to facilitate access to the SMP material and enable independent work e.g. working with another pupil (this option is stated on some SMP booklets), checking answers with a calculator, as well as using audio tapes for some topics and homework. This approach might result in Derek being given the chance he wants, to achieve success in maths, in spite of his literacy difficulties. The result will depend on his ongoing commitment to hard work.



## 4d STEPHEN

Access Mathematics Report for STEPHEN (S. F. Simmons 26.02.01)

**My work: present**—Investigation of Uses of Audiotapes for Mathematics for Students working towards Key Stage 3. (3<sup>rd</sup> year Doctoral Research)  
**past**—established and developed VI Service in Southwark, including small scale audio unit (post ILEA)

**Background:** I have worked with Stephen since June 2000 in mathematics lessons and the Audio lunch time club (C.H.A.M.P.E.)

**Positive aspects:** Scott is keen to learn. He is a competent tape user. He is reliable and responsible and this term ran the Club without adult help.

**Negative aspects:** Stephen has difficulty: (a) accessing material in books and on the board in red. (b) reading joined up writing (c) seeing small print and complex diagrams (d) completing long assignments in lessons/exams within time allowed for his fully sighted peers.

**Examples of Successful methods tried:**

1. Questions and descriptions of diagrams on tapes used with enlarged print. *Ideal arrangement* tapes ready for lessons/tests/exams a week in advance.
2. Advice and training for 'extraction' listening skills.
3. Not withdrawn. Occasional assistance when needed in lessons.
4. Shorten some assignments in consultation with subject teacher.
5. Photocopy materials written in red in textbooks and enlarge (130-141%)
6. Guidance about how to write brief answers and show necessary working.
7. Verbalisation by the teacher for board work and displays in black pen.

**Future requirements:**

1. Immediate provision of variable speed tape recorder without speech distortion. Headphones usable with mono or stereo equipment. Rechargeable batteries. Battery recharger that also discharges. External microphone.
2. From May 2001, a Teacher to take responsibility for in lesson support, liaising with maths teacher and department, concerning decisions about which materials to: record on tape, photocopy, enlarge, omit, decrease in quantity. Support teacher/assistant to record, copy and label tapes and photocopy.
3. Advice needed to assist verbalisation during board work e.g. use of compass directions and angle size to describe diagrams.
4. Ongoing training for Stephen in class to develop listening skills, use of Low Vision Aids and other strategies to access information quickly and easily.
5. Secure storage place for equipment that Stephen can access. He is able to take responsibility for obtaining and returning items given the opportunity.
6. Scott should sit centrally, bring his glasses to school daily and use these to assist vision and improve posture when working. He is the best judge of when to use his glasses. Stephen should be encouraged to tell teachers why there is difficulty seeing displays on the board e.g. reflection, size etc.

**N.B. Before I finish my practical research work, in May 2001 (after SATs)** I am willing to give advice and training about production of tapes and their uses to the teacher, who will take over the support work with for mathematics.



## Appendix 5

### Narrating

#### 5a GUIDELINES for SCRIPT WRITERS

Guidelines for Scripters 11.9.99 (S. F. Simmons)

\*\*Tapes are intended to be suitable for Braille as well as print users.

##### GENERAL AIMS and ISSUES:

1. To emphasise combined problem solving.
2. To keep content related as far as is acceptable to the original, published material.
3. To be prepared to explain to publishers and others, reasons for changes made to content and presentation.
4. Script content/presentation needs to take into account:
  - (a) variation in the ability of users e.g. Braille contractions and description of layout for users with no sight, short term memory, English as a second language, tendency to misread numbers.
  - (b) use by supporters—the script *not* the original worksheet will be available in the filing system for supporter to use to assist users e.g. for checking answers and generally progress, when queries arise.
  - (c) consistency for narrators when reading scripts.
5. scripters to have an overview of the whole scheme i.e. mathematical content of materials preceding and following the level of the topic being scripted.
6. Use 'we' not I when explaining examples and practice questions.
7. Use original wording and order of information stated in the maths scheme for questions and exercises whenever possible e.g. if the wording refers to 'you', use this pronoun in the explanation, repeat important phrases e.g. 'is my answer sensible?' *N.B. Remember the user cannot glance back at these when using tapes*
8. Detailed discussion is required if mathematical changes are to be implemented e.g. different method for explaining multiplying by ten. Contact with the publisher is necessary for this type of change but diagram/picture descriptions to enable access for Braille users are at the discretion of scripters
9. If the number of the exercise does *not* correspond to the numbering in the text, use square brackets to enclose this at the end of the answer (any writing in square brackets is not read onto tape) e.g. Exercise 13. A firm employed four hundred and thirty-six, 436 people. How many people were employed to the nearest ten? [24 part (a)] (this shows that exercise 13 on tape is exercise 24(a) in the scheme)
10. Do *not* give detailed information about how or where to write abbreviations or how to lay out calculations. (tapes will be used by Braille users)

N.B. More suggestions for and queries about these guidelines welcomed.



## 5b GUIDELINES for NARRATORS

### Draft Checklist for Recording using Sony TCM 465V (S. F. Simmons)

N.B. Sections in *italics* give information sources, these are not printed on the list.  
*"The ideal is that all information available to the sighted reader be made available to the reader with a print disability"* (first draft, 'guidelines on Conveying Visual Information' Round Table, Australia and N.Z April 98)

#### General:

1. Use a script when recording. *"NEVER, NEVER read at sight with no preparation"* (G. Webster)

FIRST announcements: tape number, side, topic, source (book/sheet page number).  
 e.g. Tape 1M, side A, 'Handling Data'--'Drawing conclusions from graphs', level 5 pages 39 and 40

END announcements: this is the end of tape number, side, topic.

Key Stage 3 Mathematics, Level by Level by Stafford Burdred was first published in 1995 by Pearson Publishing Limited. Permission for audio reproduction has been given to S. F. Simmons, by Pearson Publishers, for research purposes. Copyright conditions apply.

2. Erase mistakes made when recording, do not apologise and read again.

*"If you make a mistake ERASE and RE-RECORD. Never apologise and read it again."* (A. Hart)

3. Use punctuation for pauses and to guide voice intonation e.g. question marks.

*"...there should always be a vitality injected into your voice."* (G. Webster)

4. Do not try to read for more than an hour.

5. Record a short section, then playback to test the machine and conditions.

*"Try a test tape"* (COTIS)

Use the pause control to stop the recorder then press 'stop'--remember to turn up volume control to listen and set to minimum before recording again.

6. After recording, check content and timing of tone-indexing for user.

#### Preparation:

1. Sit facing absorbing material or out into the centre of the room

*"...hard surfaces reflect sound"* (Queensland Narrating Service)

2. Place the script and book/sheet so reading and page turning is easy

3. Set the recorder: (a) check battery power and if you can or want to record over material on the tape to be used (b) rewind tape (c) set volume to minimum (d) set 'pause' (e) press 'record' (f) 'pop-up' microphone (g) place recorder on soft surface vertically or at mouth level, horizontally, slightly to L. or R. of mouth at about a ruler length away (have a hard surface next to the recorder if using pencil taps)

#### Recording:

1. Release 'pause' and count 15 seconds before read announcements

2. (T) to insert one tone--press 'cue marker' lightly and briefly once--wait 3 seconds before speak again (T)(T) to insert 2 tones wait until you see red battery light come on before pressing 'cue marker' the second time, wait 3 seconds before speak.

3. (\*\*) use 2 sounds e.g. pencil taps to give the instruction for the user to 'pause' the recorder.

#### Labelling:

Top left of tape: number of tape and initial of user--on the label: content, initials of source and page number--in space under the spools "Reproduction in any form strictly prohibited"



### 5c NARRATING MATHEMATICS

Discussion concerning 'coherent verbalisation' related to the chapter title '... One Approach to the Teaching of Linear Equations (reader 4 p.p. 158). The reason for this choice is that the topic for the unrehearsed, lesson recorded on video 19.5.00 was 'Balancing'. This happened to be the next topic on the year 9 programme. The order of topics had been decided at the beginning of the term.

Before writing any script we need to decide on answers to the following questions: Will print or Braille text be used? What wording should be used to ensure that a pupil who is 'print disabled' has equal opportunity to access the questions and information given? Which terms and methods are familiar to the pupils for this topic i.e. lead up work, basic knowledge and skills needed?

How would you present the following questions, explanations and answers for pupils in mainstream classes:

Remember tape users eventually choose whether they just want to follow the text or just listen and refer to diagrams when necessary.

1. "These scales balance. All the tins weigh the same." (diagram of scales shown in the print book)... "Which of these will not upset the balance?"  
(a) Taking 2Kg off each side..... (e) Taking one tin off each side.  
N.B. The listener must be able to understand *each* question. A general instruction at the beginning is not helpful for a listener. Pupils may have started the question, the lesson ends and they need to re: start at part (e).  
(Book B2, SMP 11-16, p.p54)

2. "Fill in the missing numbers. Do not use a calculator."  
(e)  $8 \times \underline{\quad} = 56$  (g)  $\underline{\quad} : 5 = 3$

N.B. No print worksheet provided, listening only.  
(Key Stage 3 Mathematics Level by Level Pack A: Level 4, Stafford Burdred, Pearson Publishing)

3.  $11 = 2y - 9$  (no text)

4. "...the first bus leaves Croxton at 08.30 and arrives at Braytown at 09.15. Derek catches the 08.45 bus from Croxton. What time does he arrive at Braytown?" 1 Mark. (print and/or Braille bus timetable provided for candidate)  
N.B. How should times be read to make the question easy for listening but not read in a manner to give more information to tape users, than is available for other candidates? Where in the question should the candidate be told the number of marks awarded for the answer?

Which form of presentation would you choose and why or have you a better alternative?

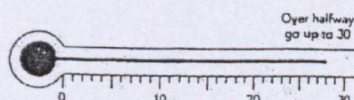
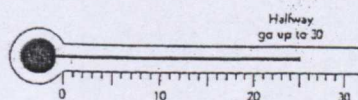
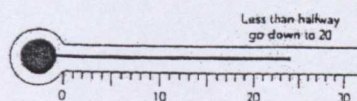
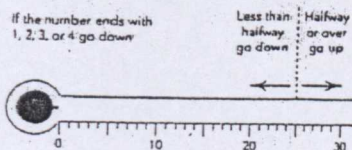
1. Assumes knows that: double means twice;  $2y$  is 2 times 'y'; substitution can be used to check answers; knows and understands that 'subtract' and 'take away' mean the same maths operations.



## 5d MATHEMATICS WORKSHEET

## Approximations

## Rounding to the nearest ten



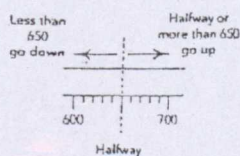
Rounding to the nearest ten

24 is nearer to 20

25 is exactly halfway, therefore go up to 30

28 is nearer to 30

Rounding to the nearest hundred



Rounding to the nearest hundred

637 is nearer to 600

650 is exactly halfway therefore go up to 700

681 is nearer to 700

## Questions

Round the following numbers to the nearest ten:

1 828

2 481

3 215

4 497

Round the following numbers to the nearest hundred:

5 783

6 623

7 350

8 28

## Answers

1 830

2 480

3 220

4 500

5 800

6 600



## 5e SELF-CHECK SCRIPT

### Approximations

Approximations. We shall work with whole numbers up to a thousand and make approximations to the nearest ten or hundred. The 6 sections are:

(1) Introduction. (2) Practice questions rounding to the nearest 10. (3) Exercises rounding to the nearest 10. (4) Practice questions rounding to the nearest 100. (5) Exercises rounding to the nearest 100. (6) Solving problems.

You need sheet A (\*\*)

(T)(T)(4s) Section 1. Introduction. Write down the title of this topic

Approximations [spell] Appr [p] oxim [p] ations. The spelling again: a p p r o x i m a t i o n s.

[KEY WORDS for this topic: approximation, approximate, approximately, digit, estimate, guess, halfway between, less than, measurement (cost, degrees for temperature ...), more than, multiply, place (units, tens, hundred or thousands), roughly, round down, round up, to the nearest ten or hundred, three digit number, two digit number, zero]

We all use approximations quite often, without really thinking about the meaning of the word. We need to know *roughly* how much things cost and what change we should get. It can help us to be able to *estimate* how fast something is moving or how much time we have. For example, if a friend buys a mountain bike for one hundred and fifty eight pounds, we say he bought the bike for about one hundred and sixty pounds and when he sells it for ninety two pounds we say he sold it for about ninety pounds. If a racing car was travelling at a speed of one hundred and twenty-three miles an hour, we would say it was going at about one hundred and twenty miles an hour. In all these examples we have rounded the numbers to the nearest ten.

When we round numbers to the nearest ten, we first think about the *halfway* point between the tens. Look at diagrams 1 and 2 on sheet A (\*\*). The first diagram of a thermometer shows that 25 is the halfway point between 20 and 30. The second thermometer shows a temperature of twenty-four degrees, we know twenty-four is *less than* halfway so we round the number down to twenty. If it is exactly twenty-five, we round *up* to thirty. Twenty-eight is over halfway so we round *up* to thirty. Another way to remember how to round numbers to the nearest ten is to say if the number *ends* with the digit 0, 1, 2, 3 or 4 round *down*. If the number ends with the digit 5, 6, 7, 8 or 9 round *up*.

Section 2, follows after a short pause.

(T)(T)(4s) Section 1. Practice questions. There are 4 questions.

(T)(4s) Practice question 1. Round to the nearest ten, 828, eight, two, eight (\*\*)

The digit 2 is in the tens place so we either round down to twenty or up to thirty, the *halfway point* is twenty-five. The number ends with an 8 and twenty-eight is *over halfway* therefore we round *up to thirty*.

Answer: 830, eight, three, zero.

(T)(4s) Practice question 2. Round to the nearest ten, 481, four, eight, one(\*\*)

The digit 8 is in the tens place so we either round down to eighty or up to ninety, the *halfway point* is eighty-five. The number ends with a 1 and eight



## Appendix 6

CHAMPE

6a





## 6a (ii) POSTERS

**Why not come to...**

BACK OF  
LIBRARY

12:45-1:15

MONDAY  
LUNCHTIME

FIRST COME  
FIRST SERVE

JUST BORROW A  
TAPE AND DO SOME  
QUESTIONS AND YOU  
ARE ON YOUR WAY  
TO A BETTER MATHS  
UNDERSTANDING!

A GREAT CHANCE TO BUILD UP YOUR MATHS

# CHAMPE

1 DAY A WEEK  
MONDAY LUNCHTIMES  
FROM 12:45-1:15

NEED HELP WITH  
MATHS?

**FIRST**

**COME FIRST**

AT BACK OF LIBRARY!!!!!!!

**SERVE BASIS!!!!!!**

WANT A CERTIFICATE?

WE TAKE  
REQUESTS!!!!!!!

**WANT TO ~~BE~~ A RESEARCH ASSISTANT?  
JUST LISTEN TO SOME TAPES!**

**YEAR8 ARE INVITED TO JOIN THE MATHS  
TAPE LIBRARY**

**IF YOU WANT TO BE ONE OF THE FIRST  
MEMBERS-- ON YOUR WAY OUT OF THE  
LIBRARY ASK FOR A FORM**



## 6b AIMS of CHAMPE

Project Organiser  
Mrs S.F. Simmons



Host Organisation

School 5

The aim of the C.H.A.M.P.E. project is to help pupils working towards Key Stage 3 SATs. The opportunity is being offered to a group of Year 9 pupils to join a lunchtime club. Pupils have been chosen, because it is felt that they may benefit from use of audio tapes for mathematics. They have been selected for various reasons, for example, they are finding reading print copy is slowing their progress in maths, they have missed or not really understood some topics and teachers report that they work hard in class and are trying to overcome their difficulties. Listening skills will be developed and independent work encouraged. When they finish a topic and can explain *how* to work out answers, they will be able to record their own audio dictionary, which they can use, later, for revision. Funding for the project is through the Millennium Commission. A recorder and earphones will be loaned to each member. Tapes are prepared by a group of volunteers, including several retired teachers. Places are limited and will be given to others if a pupil does not attend sessions regularly. Pupils must have permission from parents to become a member of C.H.A.M.P.E. and also if they want to be included in any club audio recordings, photographs or videos. If you want to know more about the project or you think that you might like to help run the club, please ask for more details.

C.H.A.M.P.E.

(Community Helped Audio Mathematics for Participation and Equity)  
Club/Library, based in Sedgemoor School, London.

For two years C.H.A.M.P.E. has aimed to enthuse young people, with or *without* sight, to enjoy taking responsibility for their own mathematical learning in a supportive social setting. They have had opportunity to help themselves reinforce, revise or fill 'gaps' in, their knowledge, through using Millennium funded equipment, choosing topics and borrowing audio materials, which include strategies for working out answers. Older community members have helped with scripting and recording, contributing their skills and experience towards research. Opinions voiced by all of us involved in this project indicate that the result has been personal development, as well as extension of ability to think, question and communicate mathematically.



## 6b (ii) AIMS of CHAMPE

### Announcement re: CHAMPE audio maths library (Year 8 Assembly)

1. We have decided to invite members of year 8 to join the CHAMPE audio maths library.
  2. This library will open on Mondays, after half term, in the school library, during lunch time.
  3. The research I have been doing in the school is going on. Help is needed from pupils. You are being given the first chance to join this audio library.
  4. Answers are given on the tapes and you are told ways for working out the answers.
  5. You can take the tapes home. It will be like borrowing a book. You must keep to the school library rules.
  6. If you want to join, ask for a slip at the desk in the library. We need your name and form and the *date* that you asked to join. The date is important, because your name will go on a waiting list. The date you asked to join, may decide how soon you can become a member.
  7. The two pupils awarded certificates today have helped with research in the CHAMPE Club since February. These certificates can be used for their National Record of Achievement.
- Reminder the Club opens as a library on the first Monday after half term. Put your name on the waiting list as soon as possible if you want to join. You can just borrow the tapes, you do not have to help with research.

S.F.Simmons      May 2001

### SUPPORTING (please add ideas to these guidelines to help other supporters)

1. Listen alongside the user and give assistance when needed, encourage the user to ask for help when needed. Discuss methods and topics.
  2. Use the script for checking answers and progress
  3. Check:
    - (a) The date is written before start listening.
    - (b) Name and the title of the topic is on each sheet of paper
    - (c) Exercises are numbered clearly. PQ is written before the number of a practice question.
    - (d) Answers are short but include words/units as well as numbers when necessary e.g. 8 tickets, 15m (abbreviations used when possible)
    - (e) When a topic is finished ask the questions at the end of the script to check understanding and note answers.
  4. The 'pause' slider is being used to stop and start the tape when listening.
  5. The use of the speed control is understood to speed up or slow down the tape. Normal speech speed is shown by a white line on the control wheel.
  6. Can find the 2 tones at the beginning of practice questions i.e. Press down 'play' then: (a) fast forward, release this immediately after the 2nd tone OR (b) rewind, then release immediately a tone is heard.  
N.B. 1 tone is used for exercises.
  7. Note comments about success, difficulty and improvements suggested.
-



**6c BULLETIN****WHAT'S NEW?****1.12.99**

**LUNCH PASSES:** new passes will be available on 5th January 2000. The yellow passes issued this term will *not be valid*.

**BORROWING TAPES:** when you return tapes, please rewind them to the beginning of side A. Tell us what was good about the tape and any way we could improve it.

**BREAK** as well as **LUNCH** time opening in room 107, on Wednesdays will continue next term *if some members want to come at that time*.

**EQUIPMENT LOAN:** forms must be taken home and signed by parents *before* recorders and batteries can be borrowed.

**LAST WEEK'S NEWS**

Year 8 pupils who attended last Wednesday, borrowed one of the introduction tapes 'Tables' to take home.

Year 9 pupils who attended last Wednesday borrowed recorders and batteries as well as the 'Decimals' tape requested by one of the members.

**HOW MEMBERS CAN USE THE CLUB:**

1. Talk to other members and find out what they are doing, successes/difficulties.
2. Change a tape and answer oral questions about the topic.
3. Exchange batteries i.e. return 2 batteries and get 2 recharged
4. Complete practice questions *before* borrowing a tape and ask for help from supporters.
5. Record questions and answers for topic dictionaries.
6. Request a topic.

**REQUESTS for a topic:** please tell us the topic wanted and we will try to have the tape ready by next Wednesday.

**ACTION NEEDED:**

**IDEAS** for the last meeting this term?

**RECORDERS, BATTERIES AND TAPES** to be returned next week 8th December. These have to be checked but can be borrowed again next term.

**SUPPORTERS** to decide which activities they prefer, when helping to run the C.H.A.M.P.E. 'Audio Maths Library'.



## 6d MATHEMATIC FORMULAE for WEBSITE

### AUDIO MATHEMATICAL FORMULAE for WEBSITE

(Meeting with Richard McCracken and Elaine Barton at the 'Intellectual Property Management Office, OU, Offices 6, at 2pm on 20.01.03)

#### Proposed wording

AREAS: \*\*letters are lower case unless stated as capital, units of area are given in 'squares' for example 'cm' squared, centimetres squared.

The area of a rectangle is base length, multiplied by height  $A = bh$   
*Formula: The area of a rectangle, capital A, equals 'b' 'h'*

The area of a triangle, is half, the base length multiplied by the perpendicular height of the triangle  $A = \frac{1}{2}bh$

*Formula: the area of a triangle, capital A, equals, half, 'b' 'h'*

The area of a parallelogram is the base length, multiplied by the perpendicular distance between the parallel lines  $A = bh$

*Formula: The area of a parallelogram, capital A, equals 'b' 'h'*

\*\*\*The area of a trapezium is half, the sum of parallel sides 'a' and 'b' multiplied by the perpendicular distance between them  $A = \frac{1}{2}(a + b) \times h$

*Formula The area of a trapezium, capital A, equals a half, open brackets, 'a', plus 'b', close bracket, times 'h'.*

[RNIB GCSE tape Foundation Course: "The area of a trapezium equals a half, open brackets, little 'a', plus little 'b', close bracket, times little 'h'."

The area of a circle is Pi multiplied by the radius of the circle squared

$$A = \pi (r \times r)$$

*Formula: the area of a circle, capital A, equals Pi, 'r' squared*

[RNIB GCSE tape Foundation Course "Area of a circle equals Pi times bracket, radius, close bracket, squared—Capital 'A' equals Pi little 'r' squared—A equals, Pi, 'r', squared"]

\*\*Language used is based on the NNS, Mathematical Dictionaries, consultation with the HOM in the school where CHAMPE is established, Linda Pearce RNIB and GCSE tapes supplied by the RNIB (London GCSE Mathematics, Heinemann 1996). QCA comments requested.

S. F. Simmons 20.01.03



## 6e REPORTS for MILLENNIUM COMMISSION

Age Concern Millennium Awards - Award Winners (First Report (to be submitted to ACE, Millennium Awards Co-ordinator, by 1 August 1999))

Susan Simmons - Mathematics teaching

Ref: 00050/1

Actual numbers of participants against anticipated numbers:

young people: (target 20 by end of 1st year)

12 year 8 pupils, identified as possible users of tapes. A pilot group of 4 have undertaken initial training. 5 sixth form pupils are involved as helpers.

older generation: (target 20 by end 1st year)

13 narrators and/or scripters trained, bank of 3 established, liaison person re: tactile materials, quality assurance person for administrative information, mathematics advisers (3 one in Australia), technical adviser.

others: 1 parent (Session Administrator)

Host organisation *Sedgehill School* main participants: headteacher (Supervisor), bursar, office staff, head of year 8, second in charge mathematics of mathematics (Project Co-ordinator), media resource officer and assistant.

Representatives of Organisations: technical adviser (audio specialist A & M Electronics), Manager of Audio section (Central), Customer Information Centre (Sony, Managing Director), Director of organisation supplying tapes, Managing Director of publisher (giving permission for audio reproduction for the project), Narrating Service (Australia), Managing Editor (Bradford Talking Magazines)

Activity during the first three months of the project:

The title of the project has been agreed: C.H.A.M.P.E. (Community Helped Audio Mathematics for Participation and Equity). Design for posters and headed notepaper have been submitted for production by host organisation. Liaison meetings have taken place in Sedgehill School, as issues have arisen. Use of facilities and advice have been made available in the school by the media resources department.

The unacceptable quality of the first batch of recorders received, has influenced the order of events. Priority has been given to writing scripts incorporating mathematics, to introduce listening and recording skills. Scripts are on computer and have been trialled by individuals/small groups of participants, alterations made when necessary. The children have been selected through consultation with the head of year 8 and special educational needs staff and reference to year 8's general National test results. The first group have been trained to use the equipment and tapes. A series of 12 tapes has been agreed and work is in progress scripting and recording these ready for use. Participants are enthusiastic and are giving their time and expertise generously to ensure that the project progresses as successfully as possible. All suggestions for improving general organisation and tape production and use are valued and changes are implemented as appropriate.

The opportunity to use audio tapes to complement mathematical learning is beginning to become a reality for some children and will be offered to more in September. The older generation are realising that with their wealth of knowledge and experience, they still have an invaluable contribution to make to education. All participants are benefiting from this unique chance, made possible by the Millennium Commission funds awarded through Age Concern, to put this innovative approach to independent mathematical learning into action.



## 6e (ii) REPORTS for MILLENNIUM COMMISSION

Age Concern, Millennium Awards - Award Winners (Final Report)

Susan F. Simmons (12.03.01) – Audio Mathematics Club

- **Participants:** Over 50 young people in years 8 and 9 in *School 5* have had the opportunity to use the audiotapes to help them to re-enforce, revise and fill in gaps in their mathematical learning. The initial older-generation members are still voluntarily working to assist with production of the tapes and implement changes based on feedback from tape users.
- **Host Organisation** – the Headteacher and MRO have continued to support the project. There has been no School Co-ordinator from the mathematics department, since September 2000. The club has transferred to the library and is receiving strong support and interest from the librarian. The school has referred students for membership, which has been limited by the equipment available and quantity of tapes that could be produced.
- **Project Achievements:** The Award has enabled low cost, portable equipment suitable for the context of this project, to be purchased and running costs to be funded. When tapes have been piloted in the Club master copies can be stored on the CD writer. It has been a learning experience for both the younger and older generations to listen to and value the ideas and the views of each other. The communication and trust established through this process has resulted in improvements of tape production and organisation of the C.H.A.M.P.E. Club.  
The young people who have had the opportunity to try this method of accessing information are the best judges of the success of the project. The self-help tapes and certificates awarded for assisting with research as well as attainment have resulted in the development of positive attitudes to mathematics. One example of increase in self esteem and confidence is demonstrated by the efficient way in which two Year 9 students are able to run a Club session, without adult intervention. One of the students is partially sighted. The project has been designed so that people with disabilities can use the tapes and undertake administration for the Club. Each student has decided whether listening to information does assist them. Their opinions have been documented over the past eighteen months. The interest and enthusiasm expressed by those who have found the tapes helpful is evident. Some of the discussions have been recorded on audio and video tapes.  
Winning the Award has meant that I have been able to extend my doctoral research, in which I am investigating uses of audio materials for mathematics in mainstream schools. I hope that this will benefit many more students.
- **The Future:** the C.H.A.M.P.E. Club is gradually changing its role to a Library. Tapes are labelled with a bar code and checked 'out' and 'in' on the school library database. Discussions concerning continuation of running this project within Sedgely and/or other schools or libraries and extending membership to more students are still in progress. The involvement of an interested adult, with knowledge of the National Numeracy Strategy and funding are key issues that must be considered.



6f (i) CHAMPE CERTIFICATE



# RESEARCH ASSISTANT'S CERTIFICATE

NAME .....

FORM .....

DATE .....

The above student has attended Club sessions and completed questionnaires to evaluate content and presentation of mathematics on tapes. This pupil has demonstrated the following skills :-

- ♦ completing a questionnaire on each of the topics listed on this certificate to aid research.
- ♦ suggesting ways to improve content and presentation for each topic.
- ♦ making judgement about how helpful the methods and explanations are in the Introduction and Practice Questions for the topic.
- ♦ finding and correcting errors in content or recording on tapes.

Questionnaires have been completed on the following topics:

*Place value*  
*Approximations*  
*Using a calculator*  
*Calculator skills*  
*Addition and subtraction facts*  
*Addition and subtraction (mental arithmetic)*

signed.....

date.....

C.H.A.M.P.E. Community Helped Audio Mathematics for Participation and Equity



6f (ii) CHAMPE CERTIFICATE



# MATHEMATICS ASSISTANT'S CERTIFICATE

NAME .....

FORM .....

DATE .....

The above student has completed the C.H.A.M.P.E. training programme and demonstrated the following qualities and capabilities :

- ♦ ability to use initiative and also undertake tasks independently
- ♦ taking responsibility for running C.H.A.M.P.E. Club sessions
- ♦ Contributing opinions and ideas in meetings to develop the C.H.A.M.P.E. Club/Library and put agreed decisions into practice
- ♦ knowing when to request advice and putting this into practice effectively

## AUDIO-MATHEMATICAL ABILITIES

- ♦ recording 2 tapes, with answers explained, up to the standard required for level 4 Key Stage 3
- ♦ using the methods agreed for recording tapes including tone-indexing
- ♦ guiding other students to help themselves choose and use tapes
- ♦ demonstrating and explaining how to use equipment provided through the Millennium Award

signed.....

date.....

C.H.A.M.P.E. Community Helped Audio Mathematics for Participation and Equity



6f (iii) CHAMPE CERTIFICATE



# TECHNOLOGY ASSISTANT'S CERTIFICATE

NAME .....

FORM .....

DATE .....

The above student has demonstrated the following qualities and capabilities working with the CD Writer and associated equipment, funded by the Millennium Commission for the C.H.A.M.P.E. Club/Library:

- ♦ ability to use initiative and also undertake tasks independently
- ♦ willingness and ability to offer effective assistance to others
- ♦ good communication and interpersonal skills
- ♦ knowing when to request help and ability to put advice into practice

## TECHNOLOGICAL ABILITIES

- ♦ setting up and taking responsibility for hardware
- ♦ testing and using the software to copy recordings between tapes and CDs
- ♦ writing a file which gives step by step instructions for using the CD writer and the programme 'Cool Edit'.
- ♦ storing and transferring information to tapes, CDs and DVDs
- ♦ verbally explaining the process to others

signed.....

date.....

C.H.A.M.P.E. Community Helped Audio Mathematics for Participation and Equity



## Appendix 7

### Technology

#### Ta AUDIO HARDWARE

I am trying to find :

1. the smallest possible recorder with the following facilities for children with visual impairment to use in mainstream classes for mathematics:

- (a) good quality sound
- (b) easy operation by children with little or no sight ( especially inserting and removing cassettes and volume/pause/recording controls)
- (c) lightweight but stable on a flat surface (the Handicassette is not)
- (d) mains or battery power
- (e) revolution counter
- (f) cue and review (chatterback effect)
- (g) variable speed without pitch distortion
- (h) ear phone socket (2 or more users with an adapter)
- (i) external microphone socket
- (j) method to record using tone/voice over indexing with tapes usable on standard recorders, not only on 4 track or special machines.
- (k) low cost

N.B. it seems probable that one recorder will not have all the features listed, it may be necessary to opt for a small recorder, without the tone-indexing facility or pitch distortion adjustment and a second machine for recording purposes.

2. tapes on mathematics suitable for children aged 8-13 yrs on other topics as well as questions on pure number e.g. Data Handling, Time, Shape, Angle, Measurement etc. Addresses including E-Mail and telephone numbers of people producing tapes and suppliers would be useful.

3. methods for children to give answers on tape without someone required to transcribe these, those who have additional difficulties often find writing slows down progress in mathematics.

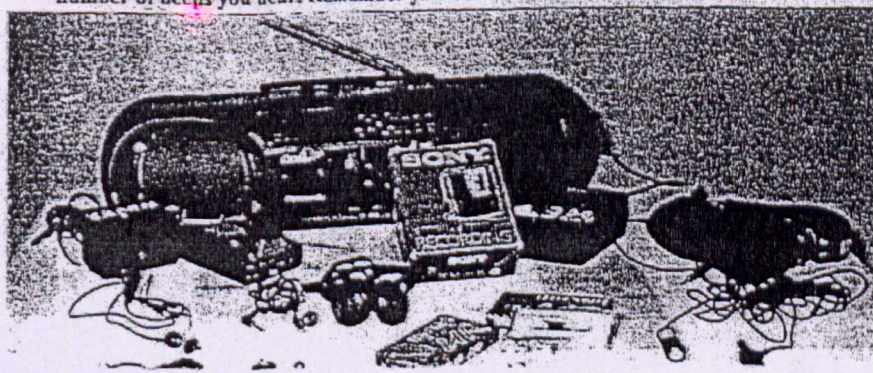
*Susan F. Simmons*

1998



## 7b OPERATING SKILLS

1. Place the tape on the table with side A facing up. How do you know?
2. Put the tape into the recorder ready to play side A. (could say side B)
3. Set the volume to 'normal speed'. How do you do that?
4. Set the volume to about half way between 'loud' and 'soft'. How do you do that?
5. Set the recorder to 'pause'.
6. Press the 'stop' button, what happens? How do you know which is 'stop'?
7. Set 'pause' again. What shape is the play button? Press it down.
8. Plug in the earphones. Which ear should the longer lead go to? (trainer should use an adapter now, and own earphones)
9. Make the tape play and listen, does it make any difference if you change the switch on the earphones from 'M' (mono) to 'S' (stereo)?
10. Listen to the tape and write down the title, you can 'pause' the tape at any time, to give you time to write.
11. Pause the tape. Find the fast forward button. How do you know?
12. Press 'play'. When you release 'pause' and listen to the tape again, hold down 'fast forward' until you hear a 'beep' and then *quickly* take your finger off the button and listen to the question.
13. When you hear 2 taps at the end of a question, 'pause' the recorder and write down your answer *before* you listen to the answer. Try and find another question.
14. Miss out the next question and do the one after that.
15. Use the rewind button and go back to the beginning of the tape. Count the number of beeps you hear. Remember you can turn down the volume.





## 7c WEBSITE

### Creation of a Website

#### *Aim of project:*

To provide an interactive, self-checking website for mathematics, that is accessible to users with little or no sight as well as individuals who have no problem seeing or reading print displays. Strategies for working out answers are shown where appropriate. Users are asked to record their comments, find errors and suggest improvements for content and presentation on screen and the sound recordings. Changes are made in response to feedback received.

#### *Programs used:*

Cool-edit Pro 1.2, Dreamweaver, Fireworks

#### *Demonstration web page:*

'Approximations' from Mathematics Level by Level by Stafford Burndred. Copyright permission for audio reproduction has been granted by Pearson Publishing, Cambridge, for the school intranet, where the CHAMPE Library is based but does not extend at present to the internet.

#### *Work Completed by David (Year 10):*

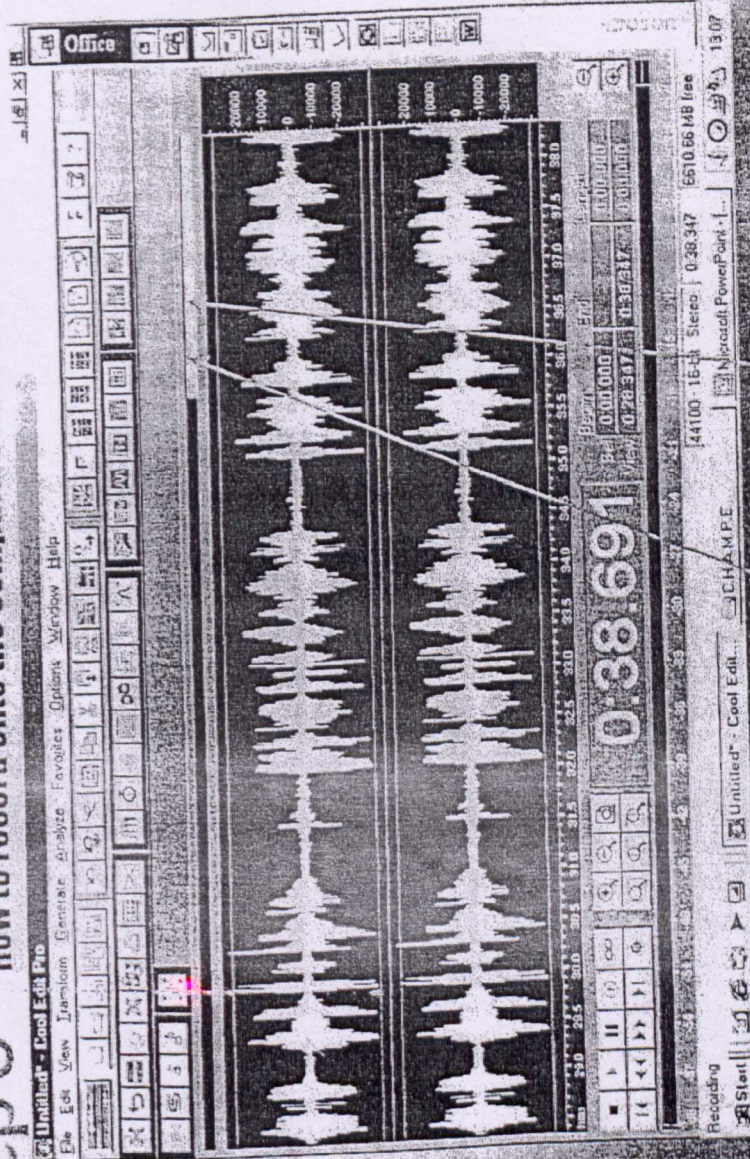
1. Storing the audiotape recordings by burning them onto CDs. The recordings were scripted and narrated by Susan Simmons, who was assisted by volunteers from the CHAMPE Narrating Service. (storing recordings on DVDs was investigated but found to be too expensive and less suitable in this large comprehensive school)
2. Step by Step instructions in colour, with directional arrows to help people 'set up' the equipment purchased in 1999 and an introduction to the 'how to use' the program Cool Edit Pro 1.2.
3. Quality of sound recordings transferred from tapes to the website was improved by removing hiss heard in the background.
4. Modified the sound track to accompany worksheets displayed on screen by removing unnecessary information and converting to mp3.
5. Mastering use of Javascript to enable viewers to check their answers and find out *how* to show working.
6. Acquired animation skills to make pages more lively and interesting to look at and draw attention to certain aspects of worksheets e.g. ways of enlarging text on screen, finding 'tools' like a calculator or formulae to help solve problems and choosing whether to listen to sound or switch off this facility.

#### *Developments in progress:*

- David is passing on his knowledge and skills to younger students
- Increasing the number of worksheets that are interactive
- Staff and students guide to using worksheets and comment page



## Step 6 How to record onto the computers hard drive (memory).



Also above the wave pattern there is a bar which gets smaller and smaller while recording. If you click on it and drag it, you will see the rest of the wave pattern.



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